WORTHINGTON 2400 I. H. P. MARINE DIESEL ENGINE
(EXCLUSIVE DETAILS)

NEW YORK SEATTLE

MOTORSHIP

Devoted to Commercial and Naval Motor Craft

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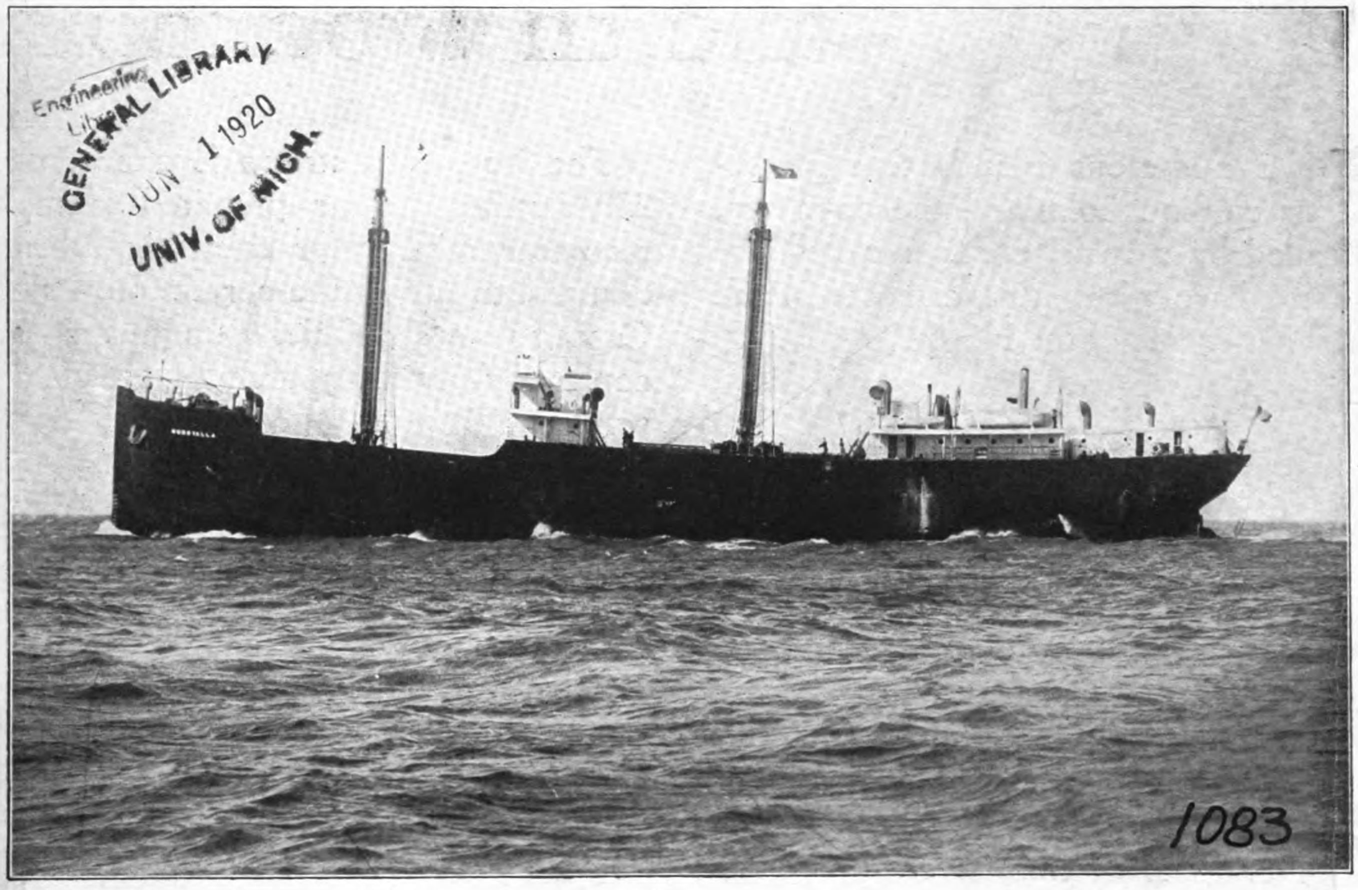

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MOTORSHIP

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A. M. S. Naval Engineers. A. M. I. Marine Engineers

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Australia—Gordon & Gotch, Sydney & Melbourne.

The oil-engined motorship has arrived! It is such a pronounced economy that it was bound to come. Nothing could stop it! And all obstacles have been removed as fast as they arose. The law of progress has seen to that. Very strong prejudices stood in the way of steam. But, one after another they were swept aside and steam reigned triumphant for a century. Steam now has had its day! Its zenith has passed, and gradually but surely it is being superseded by the economical internal-combustion power. Steamships have become decadent. America, the most important oil-producing country, is to be the greatest motorship-owning nation. Let us all co-operate and assist to make that day soon.

June, 1920 Vol. 5 No. 6

EDITORIAL

PAUL FOLEY AND THE FUEL-OIL SITUATION

IN dozens of ways the advantages of motorships to the American merchant-marine become consistently apparent and, perhaps unknown to himself, Paul Foley (Director of Operations, U S. Shipping Board), made a most eloquent plea for the adoption of the economical oil-burning Diesel-engined freighter in his recent address at the National Marine Exposition. Mr. Foley said:

> "The requirements of oil-fuel for the Shipping Board are 40,000,000 barrels for this year alone, and for next year 60,000,000 barrels, which must be transported in special carriers to selected places round the world, **failing which our steamships become as useless as painted vessels upon a painted ocean.**"

This is a timely warning against building more oil-wasting steamships and one which we have emphasized many a time. Here in two years is a consumption of one-hundred million barrels of oil, much of which has to be shipped as cargo aboard uneconomical oil-burning tank steamships to foreign stations for the use of our uneconomical oil-burning general freight and passenger carrying steamers, whose consumption of fuel is so high that they cannot carry sufficient oil for really long voyages without seriously encroaching upon their legitimate cargo space.

What a vast difference the economical Diesel-system of propulsion makes. In the *first* place, if all the Shipping Board vessels were motorships the total fuel needed for the two years would be about 33,000,000 barrels instead of 100,000,000 barrels. *Secondly* every motorship can carry sufficient fuel in her double-bottoms to voyage round the World without using here deep-tank, and so always use the latter for profit-earning cargo. *Thirdly,* it would mean that not more than a couple of million barrels of oil need be transported to fuel-stations abroad, except that needed for selling to foreign steamers and for other purposes, as only sufficient oil would be required to occasionally supply American motorships that had run short of fuel through being away from a home port for more than three months, or through some unforseen circumstances. So the number of tankers would be reduced to a minimum.

Fourthly, if the present quantity of bunker-oil that has to be transported abroad were shipped in Diesel-driven tankers, the number of ships in the oil-carrying service could be reduced by 10% to 12% because each tanker would carry that much more cargo than her oil-wasting steam-driven tanker. How many oil-companies have reflected upon the fact that a 10,000 ton tanker on a voyage to Europe burns about 550 tons of the same oil as she is carrying as cargo, and then burns another 550 tons on the trip back. Obviously this is fundamentally wrong. The same sized motorship only uses 400 tons for the entire round voyage, and so discharges the maximum of oil as cargo.

Fifthly, it shows that the present fuel-oil storage is one of the strongest reasons for building new motorships and for converting existing steamers to Diesel-electric propulsion. Such would effect an enormous annual saving of America's valuable oil. We are obliged to Mr. Foley for having stated so excellent a case for the motorship.

According to Mr. Foley "The Shipping Board has 600,000 tons d.w.c. of tankers under its operation and contract, and that this will soon be increased to 900,000 tons." Not one of these vessels are Diesel-driven, and each one is burning three times as much oil-fuel as is necessary and is carrying 10% less oil-cargo then she could if Diesel-driven. This fact is nothing more or less than a crime However, let the matter be remedied as quickly as possible and don't let us repeat mistakes. No doubt now Admiral Benson is at the head of the Nation's shipping affairs we shall get action.

America's Largest Four-Cycle Marine Oil-Engine

Details of the New Worthington 2,400 I. H. P. Merchant-ship Diesel Motor. An Engine Developed from the Best European Practices

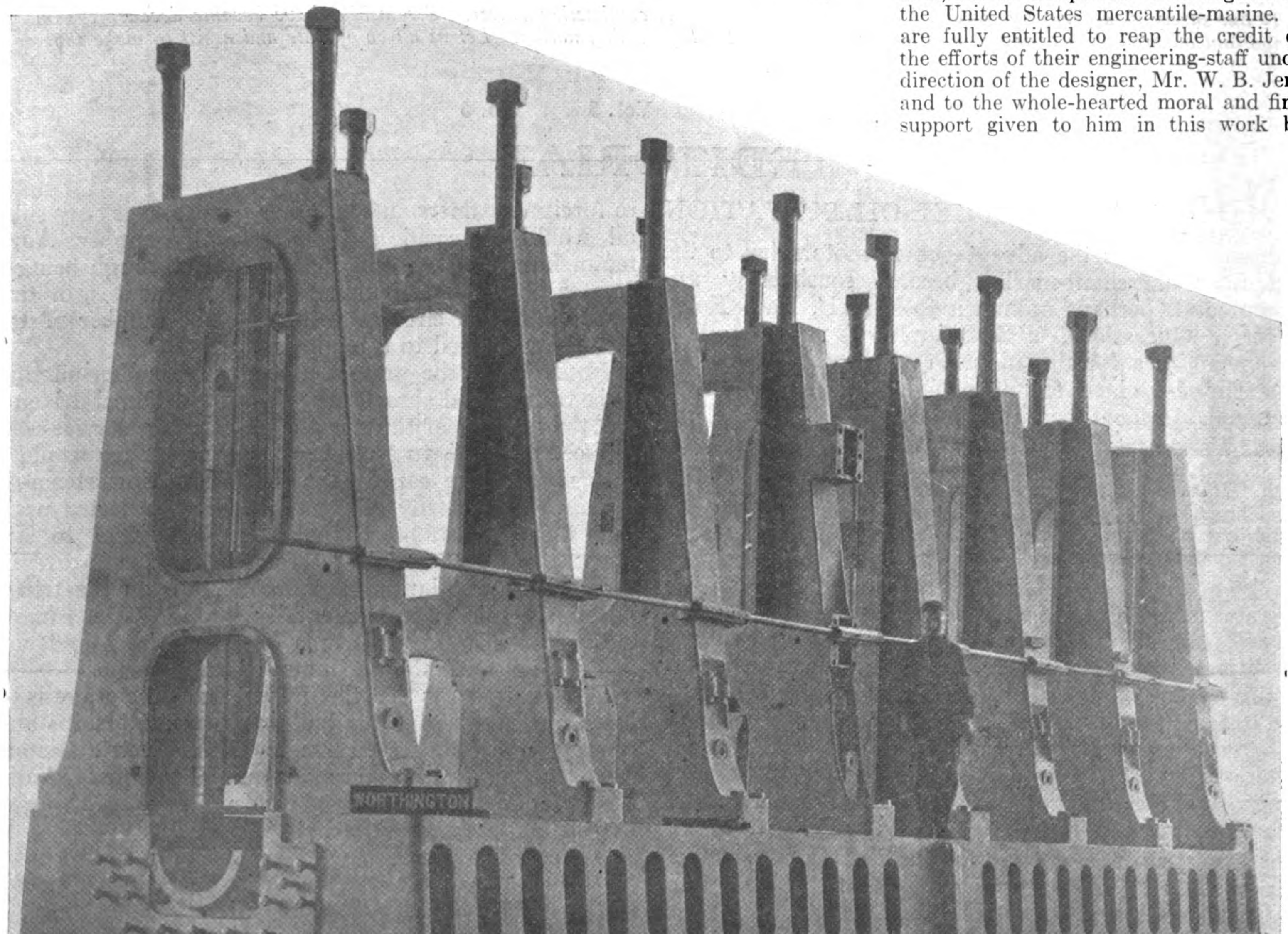
(*Exclusive to "Motorship"*)

By THOS. ORCHARD LISLE

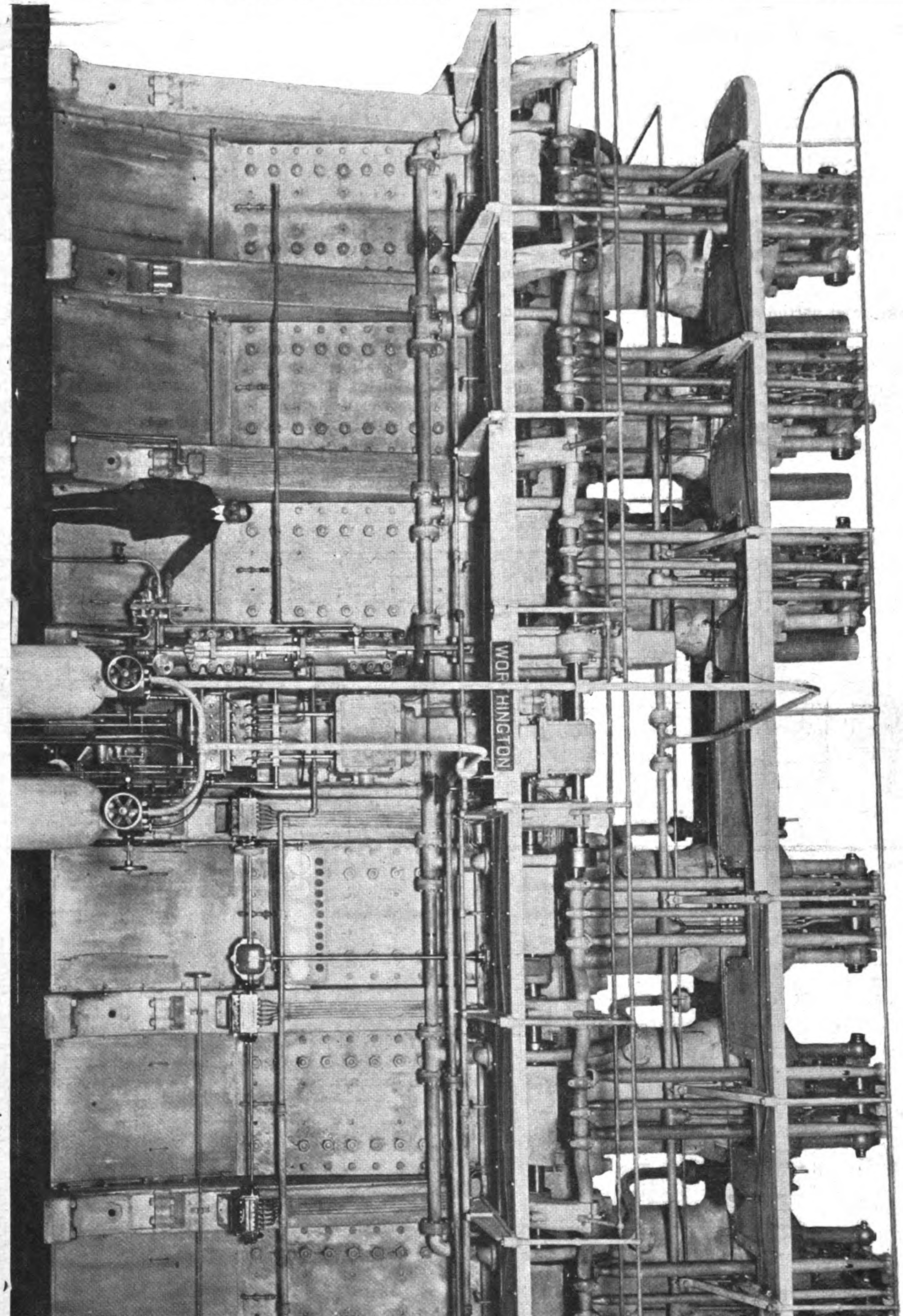
WITHOUT successful Diesel propelling engines our merchant-marine will dwindle back to its pre-war size within ten years, crushed by foreign competition. My investigations leave me convinced of this. That in the past most of our shipowners and oil-companies have given exceedingly little material aid to the builders of marine heavy-oil engines, and that with a few splendid exceptions they offer scant co-operation at the present time regardless of the foregoing serious prospect, has not prevented a number of progressive domestic engineering concerns from courageously going ahead on their own responsibility, shouldering all the initial expenses of developing and constructing Diesel-motors including sets of high power. In several instances this has been done without as much as asking for an order with a view to relieving part of the enormous outlay of funds. Yet it is shipowners who will derive the greatest financial benefits from every additional successful type and make of oil-engine 'gotten' ready for service — not the engine builders, who only receive the same percentage of profits whether they built Diesel motors, steam-engines, boilers, automobiles, mining-machinery or printing-presses. Whereas, turning steamers into motorships effects remarkable gains and economies for shipowners that cannot possibly be secured with existing steam-machinery, and will enable them to compete against the vessels of other nations, and thus assist shipowners to remain in business in years to come.

At the moment of writing I have before me a list of over twenty American engineering-firms who have built, are completing, or have just commenced construction of merchant-marine two-cycle and four-cycle types of Diesel-engines of 1,000 i.h.p. and over. The majority have proceeded about their task without any order in view and without any financial backing from shipowning interests, evidently being blessed with foresight that is usually gifted to engineers and inventors. As a rule their minds can see further ahead than the average man, otherwise their actions in building Diesel engines on their own responsibility would have indicated poor business qualities. This interesting list I intend publishing in the forthcoming issue of "Motorship."

Prominent in this list is the name of the Worthington Pump & Machinery Corporation, 115 Broadway, New York City, who have just completed a big task, similar attempts at which have resulted in heavy financial loss to some European engineers, and in one case actual bankruptcy. They have designed, built and completed without any constructional license or direct assistance from European companies who have been longer at the marine internal-combustion motor game, a merchant-marine Diesel-type crude-oil engine of large size that in design and construction may be considered to equal anything yet produced across the "herring-pond." In fact, if we take a general average of British & Continental productions to-date it is superior. What the Worthington Company have done marks an epoch, not only in the history of the firm, but in this period of the regeneration of the United States mercantile-marine. They are fully entitled to reap the credit due to the efforts of their engineering-staff under the direction of the designer, Mr. W. B. Jennings, and to the whole-hearted moral and financial support given to him in this work by the



This illustration affords an excellent view of the Worthington bed-plate and A-frame construction with its detachable section for facilitating removal of the crank-shaft. The through tension-bolts are also plainly shown



AMERICA'S LARGEST FOUR-CYCLE TYPE MERCHANT-MARINE DIESEL ENGINE

The new Worthington 2400 I.H.P. engine. The man at the control-gear is Mr. W. B. Jennings, chief-engineer of the Snow Holly Works and designer of this engine

directors and officers of the company. The latter lately allowed the completion of this Diesel-engine to take precedence over all other work.

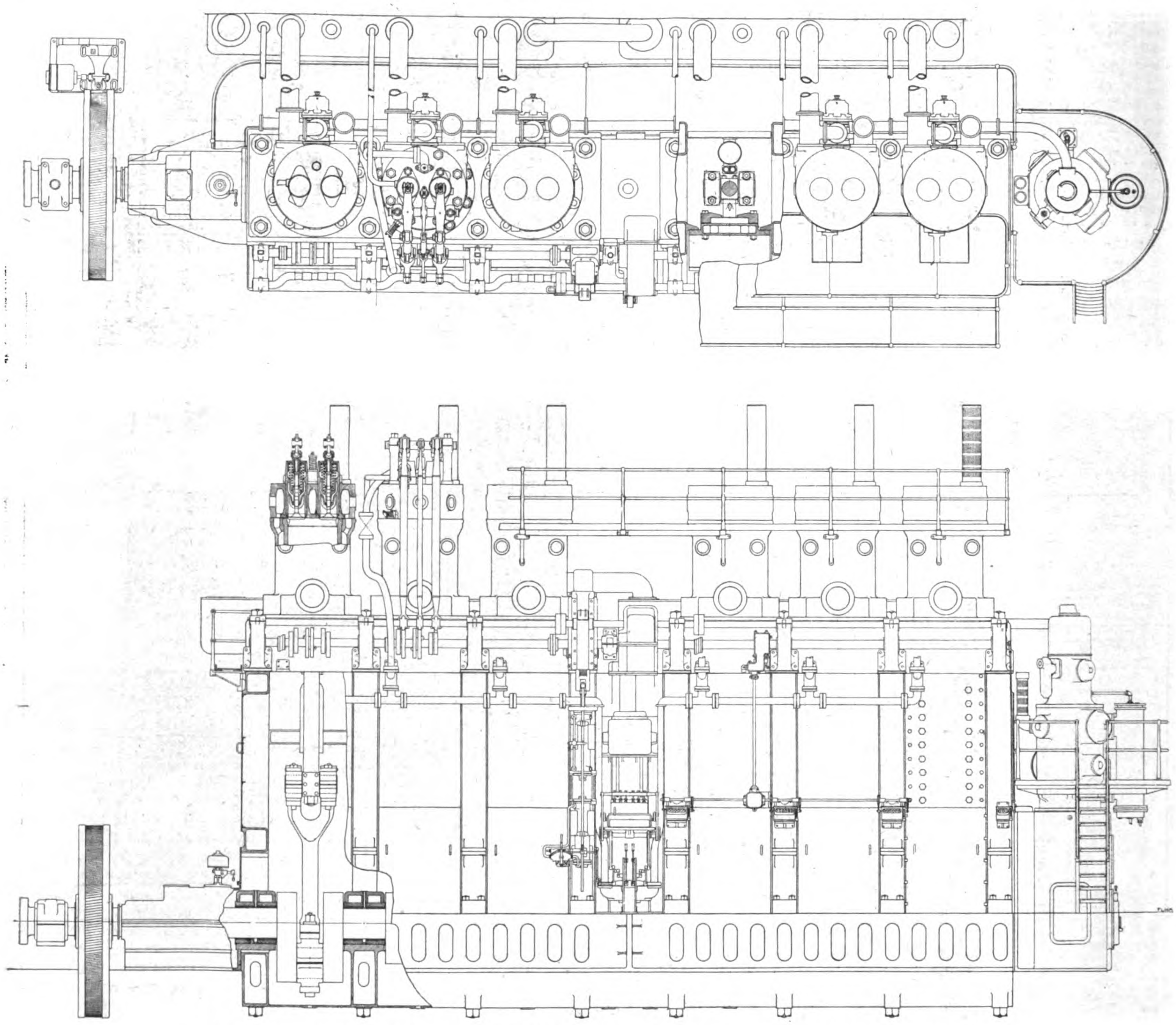
The production of this engine has evolved the expenditure of a great sum of money, which by the time all the tests are completed will have totalled half-a-million dollars. This was the original generous appropriation. Here we may call attention to the fact that while many smaller marine engineering companies have been—and still are—retrenching general and publicity expenses because of the more or less business uncertainty of the readjustment period between cessation of war and normal conditions, this great organization has tied-up this vast sum in motorship-machinery development work, and at the same time have increased their publicity expenditures in the particular field which this new engine will serve, obviously realizing the very excellent prospects and market which the motorship game undoubtedly offers to those with foresight and enterprise, and the manner in which this journal is awakening the public to its importance.

While this big engine development work has been in progress the Worthington Company have been developing a small marine heavy-oil engine at one of their other plants. This engine is for fishing-boats and commercial craft of similar size. We expect to give complete details at a little later date. For the moment we will only describe the big motors.

The merchant-ship's engine in question has an output of 2,400 i.h.p. at 120 r.p.m. and is the largest four-cycle type Diesel-engine yet completed in the United States. Through the firm's courtesy I was recently enabled to inspect this engine and witness a test run at their Snow Holly Plant at Buffalo, N. Y., where it was designed and built.

When commencing the design of this engine the Worthington Pump and Machinery Corporation decided, I understand, to adopt those practices and principles that have already been demonstrated as good engineering, but without any limitations that would prevent the incorporation of improvements that seemed proper to the designers, who have had wide and extensive experiences in the design, construction and operation of stationary oil-engines, big double-acting gas-engines and marine steam-engines. I hardly need refer to their connection with the manufacture of the largest sizes of pumping-engines for water-works, all of which is heavy machinery. Their plant at Buffalo is equipped with modern machinery, and is capable of handling all the heavy parts of this big Diesel-engine and even larger units, so they will be able to handle near future developments in motorship propelling equipment.

It should not be thought that the Worthington Company entered into the construction of this large engine without full realization of the difficulties of the great task and without complete appreciation of its many engineering problems. Because, at the back of everything in connection with this production have been their extensive experiences with stationary Diesel-engine and marine steam-engine constructions. Their Diesel-engines have already achieved the reputation of reliability on land, while for marine steam-engine production, they made a record for delivering several hundred sets in advance of delivery-date during the emergency of war. Nevertheless, the work of building a Diesel-engine along quite different lines from their previous productions has been no easy job, and I feel that a com-



General arrangement details of the 2,400 I.H.P. Worthington four-cycle Diesel-type marine oil-engine

pliment should be extended to Mr. Jennings, the Chief-engineer of the Snow Plant, and his able confrérés and assistants.

Aside from the Navy-built engines of the "Maumee," only one larger merchant-marine type of Diesel-engine has been completed in America to-date, and that is the six-cylinder 2,500 shaft h.p. (3,500 i.h.p.) **two-cycle** engine recently installed in the new ore-carrying motorship "Cubore" of the Ore Steamship Company's fleet.

The Worthington engine operates on the four-stroke cycle, is of the vertical single-acting, cross-head, direct-reversible type and develops its rated output of 2,400 i.h.p., or 1,760 shaft h.p., at 120 revolutions per minute at a mean indicated-pressure of 85½ lbs. per sq. inch from six cylinders, each 29 in. diameter by 46 in. piston-stroke. To simplify reference I give herewith the general dimensions in table form, including those just outlined:

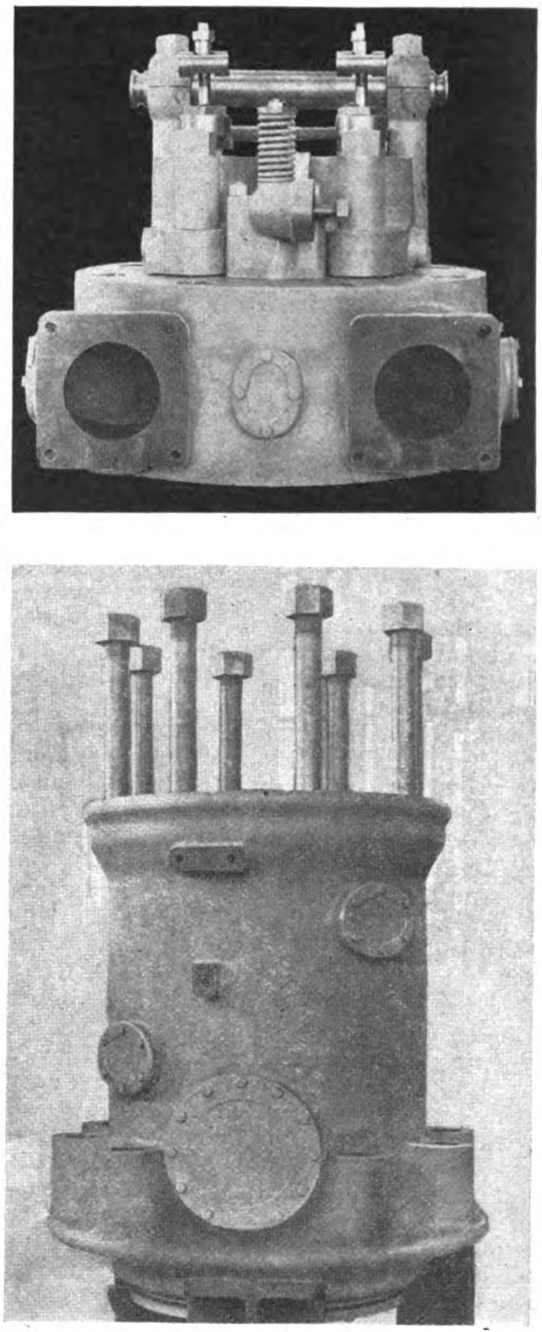
Indicated horse-power	2,400 h.p.
Shaft horse-power	1,750 h.p.
Mean indicated-pressure	85.5 lbs.
Mean effective-pressure	64 lbs.
Mechanical efficiency	75%
Cylinder bore and piston stroke	29 in. by 46 in.
Number of cylinders	6
Cylinder compression	500 lbs. per square inch
Fuel-injection air-pressure	900 lbs. per square inch
Starting-air pressure	375 lbs. per square inch
Weight (including flywheel, thrust, compressor, platforms, gratings, etc.	339¼ long tons
Weight per indicated horse-power	327 lbs.
Length with compressor	45 ft.
Length with flywheel and thrust-block	55 ft. 6 in.
Height (from crank-center to top of valve-gear)	23 ft. 10 in.
Crank-shaft (weight)	36½ tons
Thickness of Crank-webs	11⅝ tons
Main-bearings	17½ in. diameter by 24 in. long
Crank-pins	18 in. diameter by 15 in. long
Crosshead-pins (twin)	10½ in. diameter by 9½ in. long
Piston-rod	9 in. diameter
Type of thrust-block	Kingsbury

At the time of my recent visit the engine had only been given a few short runs under medium load, about 20 hours altogether, I think, so no consumption figures are available, but I presume that the fuel-consumption will eventually figure-out at about 0.30 lb. per i.h.p. or 0.41 lb. per shaft h.p. Possibly even a little better than this, as the only auxiliary equipment on the engine is the main three-tage air-compressor and fuel-injection pumps, all the water-cooling and bilge-pumps in a ship being electrically-operated by power furnished by the auxiliary Diesel-dynamo sets. On the other hand the air-compressor may absorb a little more power than usual, as it is of more than sufficient capacity to supply twin engines with injection and maneuvring air, so if the consumption is as I estimate, nothing better could be desired. With later sets the compressor may be driven, I understand, by an auxiliary engine, in which event the mechanical-efficiency and likewise the consumption would make even a better showing than my estimated figures.

The fuel on which the maker's guarantees are given is a low heating-value oil of 18,000 B.T.U. and 22 degs. Baume generally known in the oil-trade as "Diesel-oil." The oil now used for testing at the plant is 30 degs. Baume.

An idea of the general design can best be gained by reference to the illustrations, which affords better picturization than a word-description. It will be seen that the engine is of the enclosed-type with cast-iron A-frames on a heavy box bed-plate in two sections bolted together. The A-frames support a casting, which may be termed an entablature or a cylinder base. This also is in two sections joined by a distance-piece, each section resting on four A-frames and carries three working-cylinders. On this entablature the cylinders, each cast separately, are mounted. The present European tendency is to cast the cylinders in blocks of three, such as the Tosi, Werkspoor, Burmeister & Wain, and Neptune engines; but here is a feature which the Worthington designers evidently consider is better in the manner they have built it.

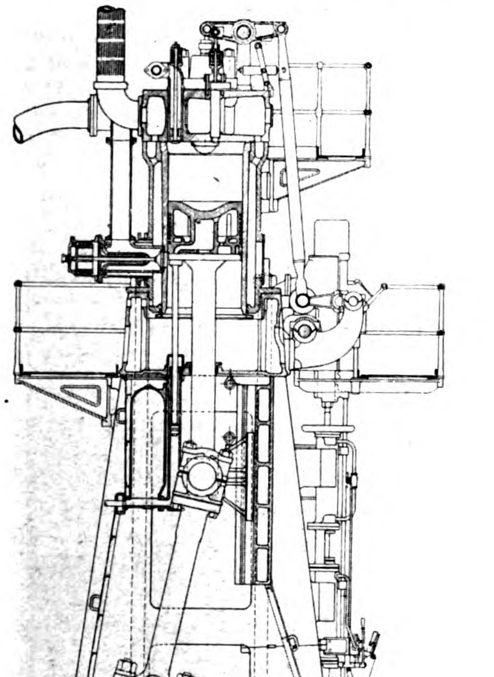
Holding-down the entablature are steel through-bolts, or tension-rods, each 5 in. diameter, and these pass through the A-frames to the lower side of the bed-plate, passing through the bed-plate close to the



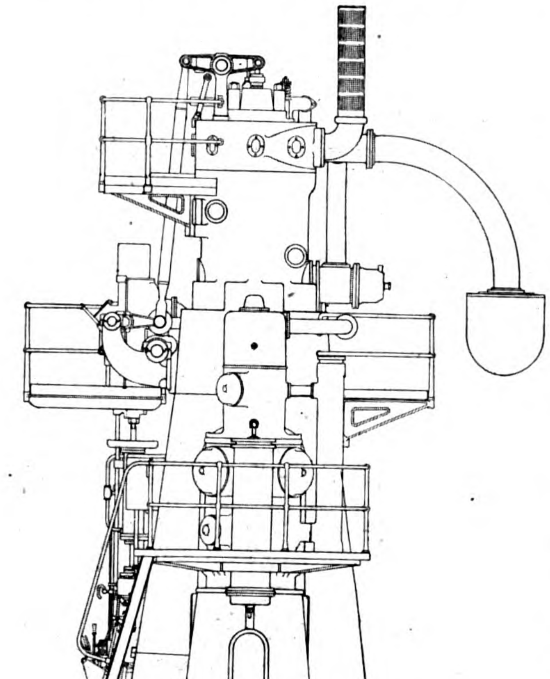
A cylinder-head and cylinder of the Worthington 2,400 I.H.P. marine Diesel engine

main-bearings so that the stress due to pressure in the cylinders is taken on the main-bearing without putting the A-frames in tension. Each cylinder is secured to the entablature by means of eight smaller steel bolts that pass thro deep lugs, symmetrically located on the lower flanges, to the underside of the entablature where it is held by nuts, thus putting the structure of the entablature in compression instead of in tension. It will be noted that the tension-bolts do not reach to the cylinder-heads, as direct bolting the cylinder-heads to the bed-plate—originated by Sulzers—has recently been abandoned by most builders who adopted it, including Sulzers themselves; although a few designers still retain the practice.

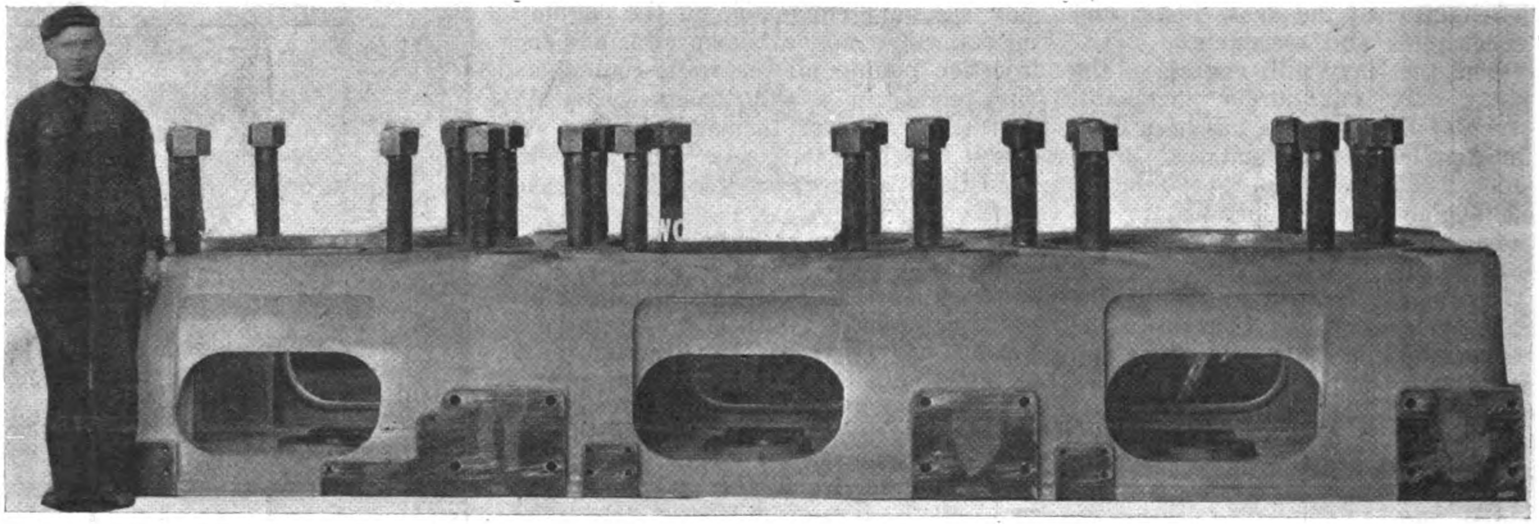
A feature of the A-frame construction, which is an American one in-as-far-as Diesel engines are concerned, and which is being adopted with another Americanized European Diesel-engines, is a removable section on the inboard (operating) side at the base of the A-frames. This section is constructed with a slight taper to facilitate its removal for the purpose of taking-out a crank-shaft should it become necessary, such as an American Bureau and a Lloyds overhaul and inspection, and adds very considerably to the accessibility of the engine. Three of the illustrations show the stages of taking out a crankshaft, which is in two sections.



Cylinder and crankcase section



View of forward end showing compressor

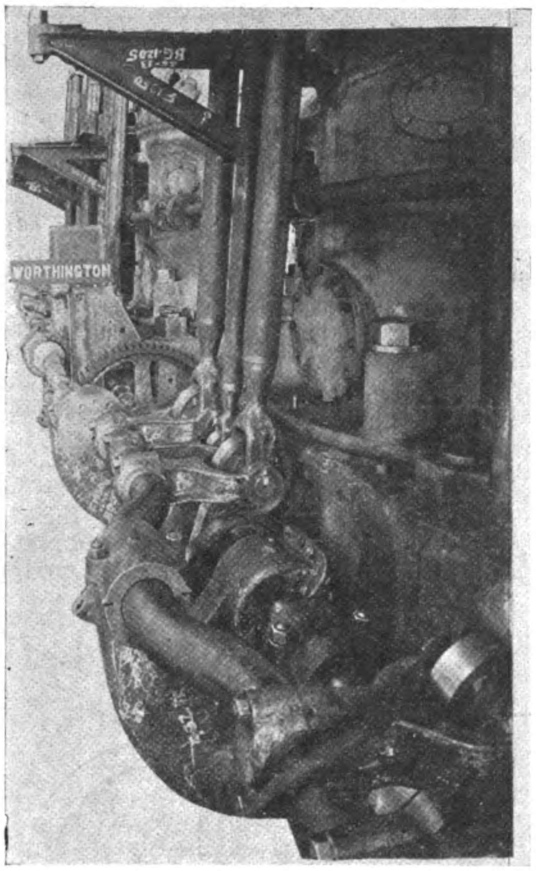


One of the two cast-iron entablatures which carry the cylinders

While the removable-piece is out, the engine is supported by means of jacks. When the detachable-section of the frame is in position, it is secured to the main part of the frame by bolts and a key. Suitable ledges are provided on the frames for supporting the crosshead-guides and the splash-plates. In the shops a crank-shaft can be removed in 5 hours, but in a ship were facilities for handling the heavy shaft are not so good, the time probably will be extended to about 10 hours. Compared with dismantling the entire engine this is a very great saving of time.

Having further regard to the cylinder-support entablature: necessary strength without excessive weight is attained by a circular member surrounding the cylinder fitting-piece, from which radial-ribs lead to the four bosses carrying the vertical thro bolts which take the load of any particular cylinder. On the back face an opening is provided permitting of access to the piston-rod stuffing-box and inspection of the cylinder bore. The front face has a similar opening, making the entablature symmetrical in form and resulting in equally distributed stresses. The bottom member of the entablature is cast solid, the necessary openings for the piston-rod and piston water-service tubes being effectually closed against leakage. This makes it impossible for any cylinder-oil or piston-water leakage to pass into the crank-pit and mingle with the lubricating-oil. The two sections of the entablature are joined by a distance-piece provided with suitable openings for the cam-shaft gear.

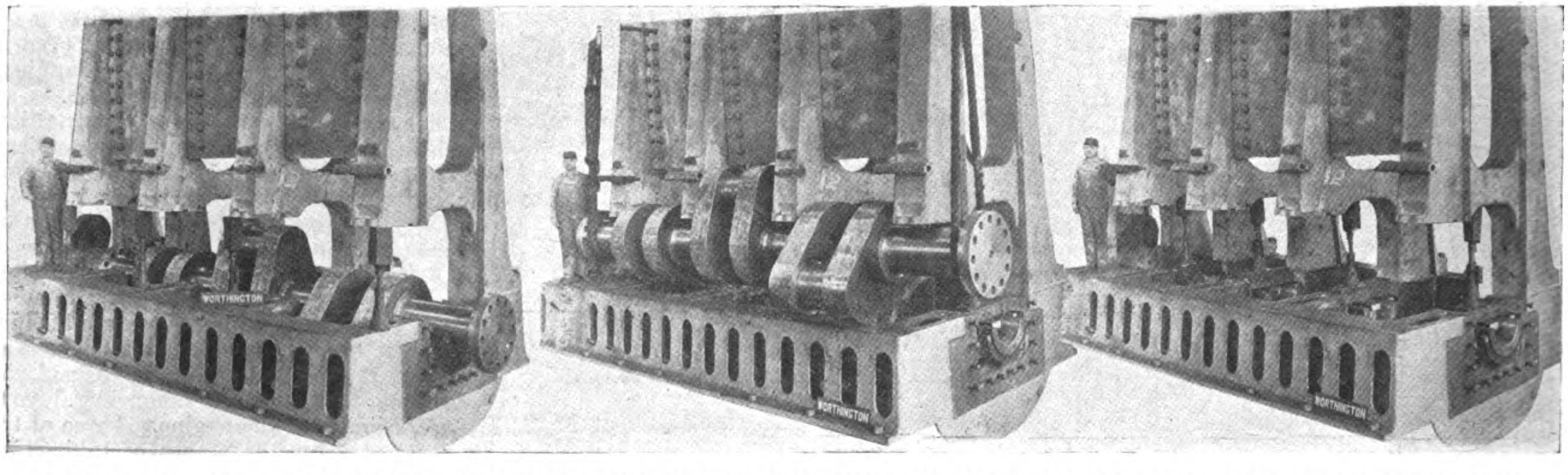
In addition to the cylinders being cast separately of soft iron, each has a separate liner of hard cast-iron, and a detachable head. While the liner is a close fit in the cylinder at the upper end, the lower end is free to expand with the changing temperature. The joint between the liner and cylinder at the lower end is made tight by a rubber-ring, which is the accepted practice with crosshead-type Diesel-engine construction. With the arrangement adopted by the Worthington Co. the liner is not hydraulically pressed in position, so can be withdrawn in comparative ease.



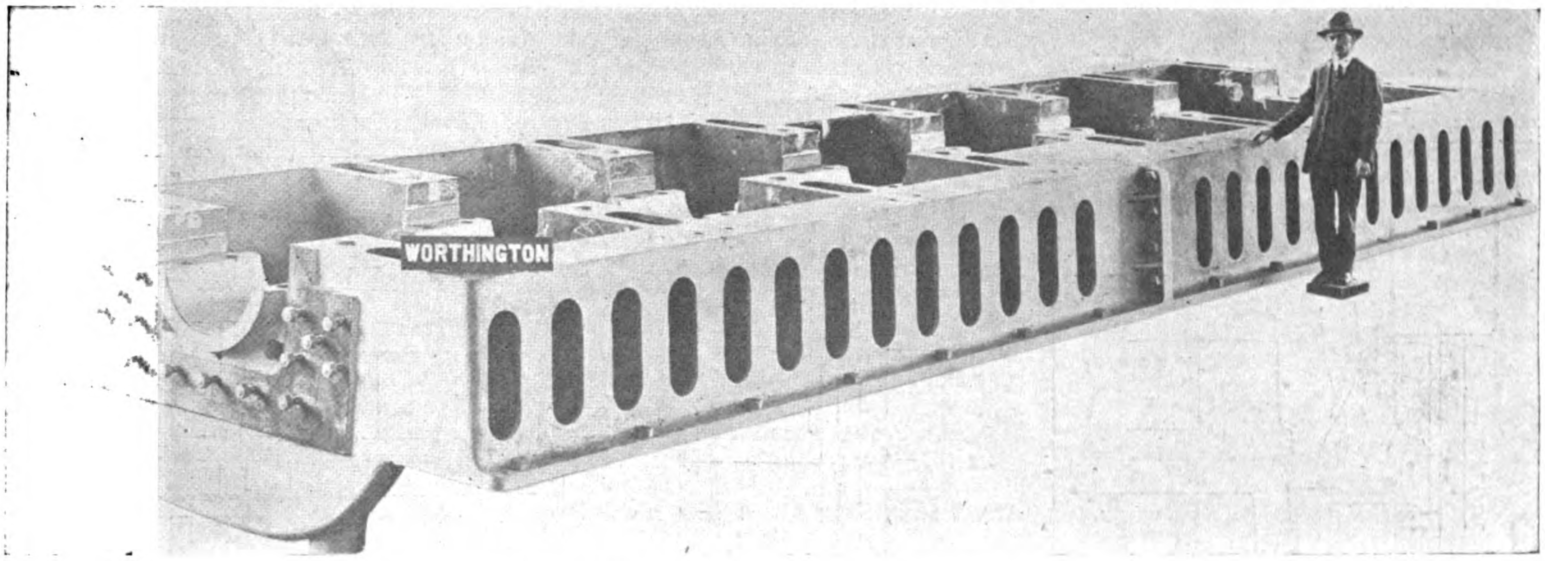
The lay-shaft running parallel with the cam-shaft, which is used for lifting the push-rods and rollers when reversing the engine. It rotates outward

With the present engine a most interesting experiment is being tried-out, namely the adoption of an auxiliary exhaust-port at the lower end of the cylinder. This takes much of the heat from the exhaust-valves. While this is not new, it has never been previously tried with so large an engine. If found so successful as anticipated it will be adopted permanently, although the engines can be built without the port. The valve controlling the flow through the port is a simple automatic-valve self-contained in a water-jacketed casing, and is fitted with a dash-pot with a view to eliminating pounding. The principle of this valve is fairly well-known and so need not be discussed at this time, except to say that by its use the hottest of the exhaust-gases are discharged just prior to the opening of the main exhaust-valve in the cylinder-head. Also when starting on compressed-air the auxiliary-port relieves the pressure at the end of the stroke in advance of the main exhaust-valve opening and so eases the load on the valve operating-gear.

In the cylinder-head there are four valves, three mechanically operated and one automatic check-valve for air-starting. On the side of the head is arranged the pressure-relief valve, which blows-off at the predetermined pressure. The three mechanical valves are the air-inlet, exhaust, and fuel-injection valves, the latter valve being offset



Three stages of rolling-out one-half of the Worthington 36½ tons crankshaft, a job which can be done in 5 hours without dismantling the engine. This feature may be considered an improvement over the average European Diesel-engine practice



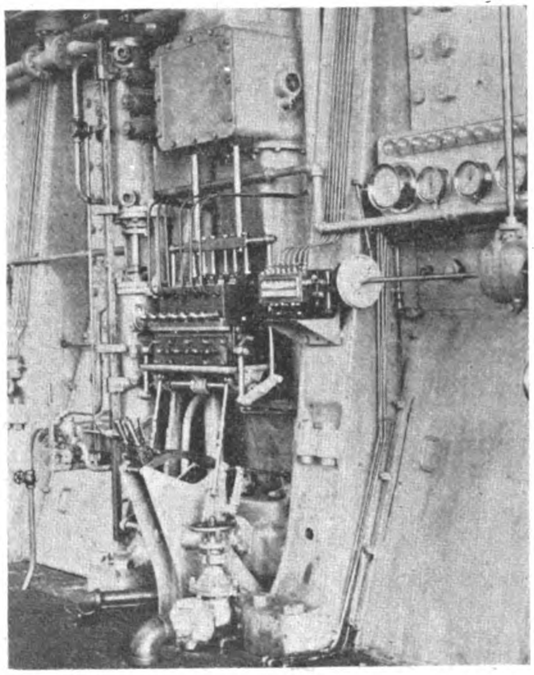
General view of the massive cast-iron bed-plate

from center, thus allowing good water-cooling space between itself and the exhaust valve. The inlet and exhaust valves and their cages are interchangeable, the valves having cast-iron heads and forged-steel stems.

As regards the air-starting valves, one for each cylinder, these are attached to the inboard side of the cylinder-entablature adjacent to the cam-shaft bearings and beneath the cam-shaft, the valve being directly under the center line of the cam-shaft. The air-starting cam acts directly on a roller in the end of the valve-stem, no levers or push-rods being required. The valve is of the mushroom type, with the stem enlarged to form a guide. Normally the valve is in its bottom position and open. In this position the roller on end of the stem does not make contact with the cam.

When the starting-air is turned on, from the operating platform the pressure raises the valve to its seat and holds it firmly closed, or brings the stem in contact with its cam, depending on the position of the latter. The valves are then in position to be operated by the camshaft. The starting-air is discharged into the cylinders by means of a short pipe connection between the starting-valve and the check-valve referred to as being on top of the cylinder.

Operation of the inlet, exhaust, and fuel-injection valves is by long "push-rods" from the camshaft which is carried on brackets mounted on the A-frames just below the entablature. These "push-rods" are seamless-drawn steel tubes of 3 in. and 5 in. diameter made by the National Tube Co. Reversing is carried out by sliding the camshaft in a fore-and-aft direction. This is accomplished by means of a disc with a diagonal slot on its circumference connected to a pinion-gear which engages with a rack attached to the piston-rod of the pnuematic reversing-engine, so that when the reversing-lever is thrown over the cam-shaft is moved fore and aft.

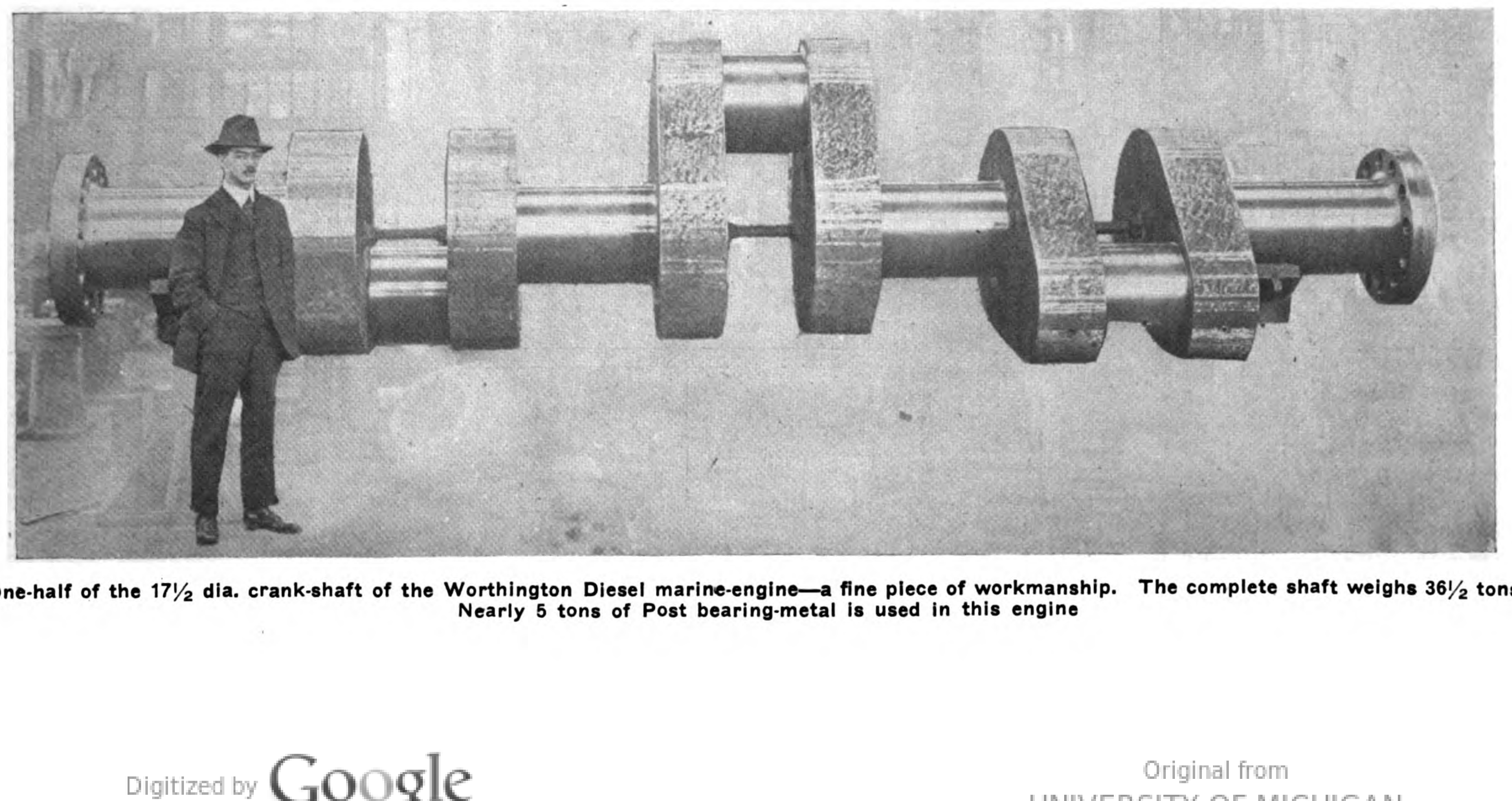


The control and maneuvring levers

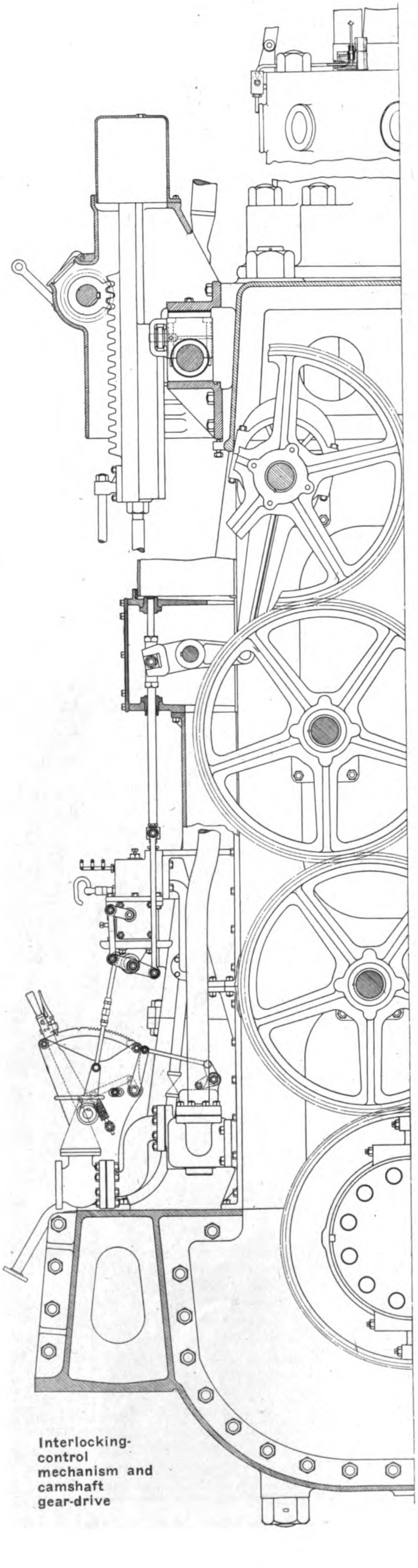
At the same time a lay-shaft running parallel with the cam-shaft is rotated in an outward direction and the cranks in this lay-shaft lift the "push-rods" in an upward direction and clear the cams and deposit the rollers of the push-rods on the cams again. When re-reversing a similar operation takes place. The rollers and cams are of cast-iron with chilled surfaces, and are of large diameter to ensure quiet running and minimum wear.

Owing to pressure on space we do not propose to discuss the main bearings and crank-pin bearings as the dimensions have been given on the tabulated details. But, it is interesting to mention that there are nearly 5 tons of white-metal in the bearings of this engine—this bearing-metal having been supplied by E. T. Post & Co. of New York, and it is of a mixture suitable to stand the heavy pressures to which bearings of Diesel-engines are subject.

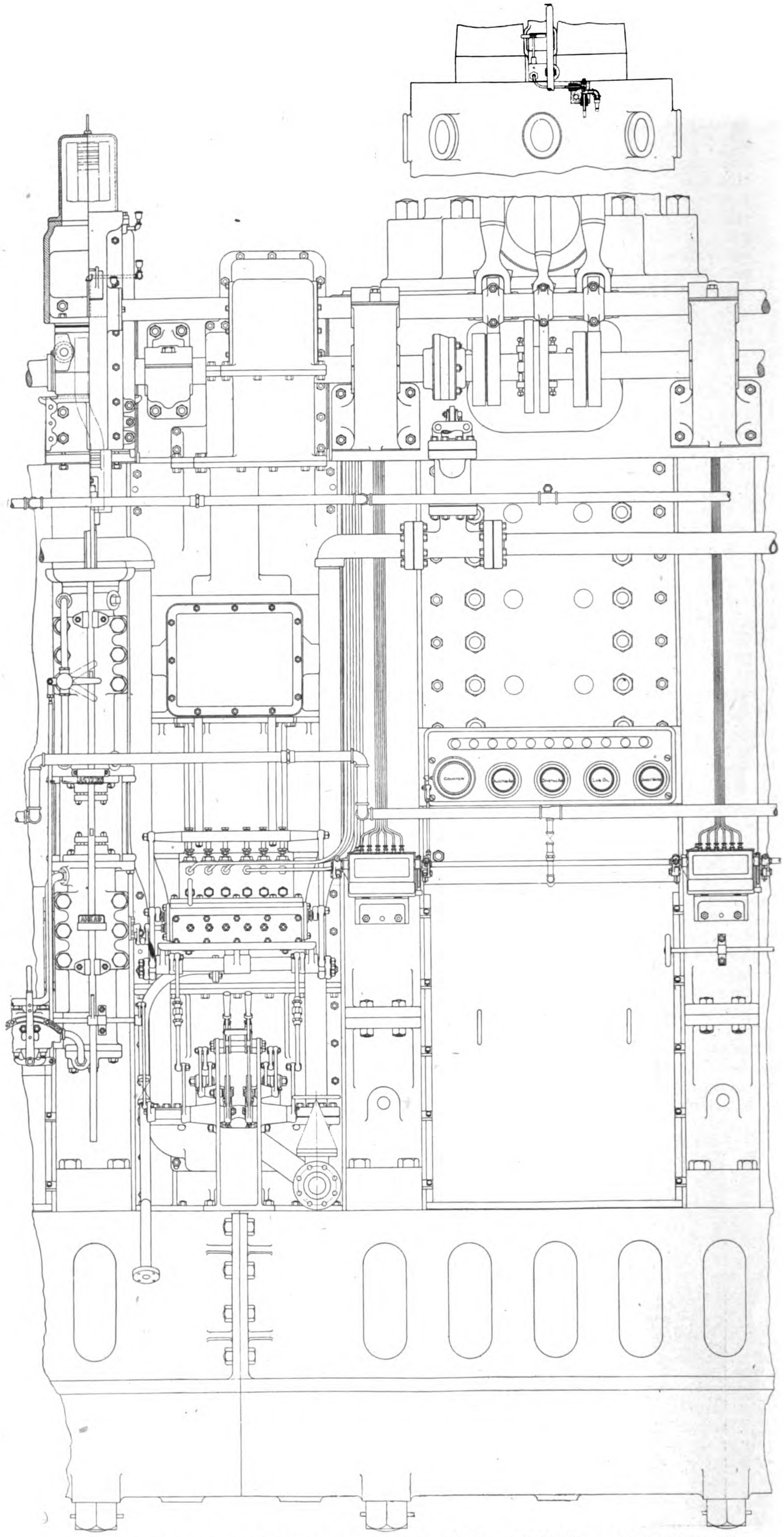
At the forward end of the engine is mounted an air-compressor for furnishing the fuel, spraying and starting-air. It is of the three-stage type, the second stage being obtained by a differential-piston. This arrangement provides a good distribution of the loads, the first and third discharge occurring on the up-stroke and the second-stage on the down-stroke. An extension of the piston carries the wrist-pin and forms a cross-head which runs in a bored guide in the compressor housing. Removable liners of cast-iron are fitted in all three compressor cylinders. There are two cylinder-castings, the lower one resting on the housing and contains the first and second stage, while the upper casting houses the third stage.



One-half of the 17½ dia. crank-shaft of the Worthington Diesel marine-engine—a fine piece of workmanship. The complete shaft weighs 36½ tons. Nearly 5 tons of Post bearing-metal is used in this engine

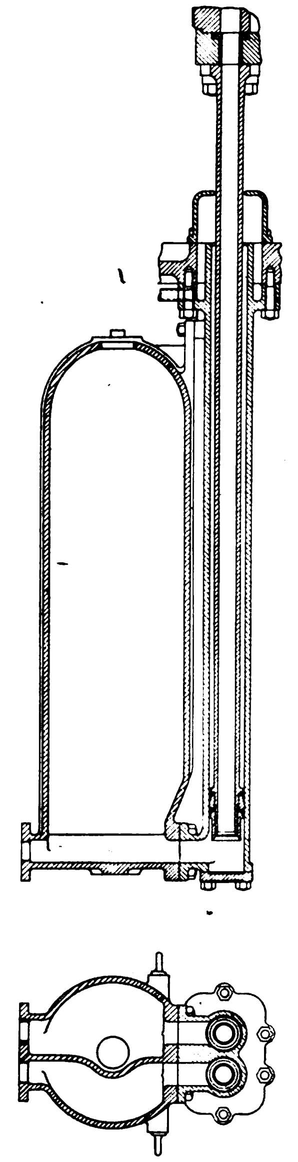


Interlocking-control mechanism and camshaft gear-drive



Interlocking control-gear, fuel-pump, and cylinder lubricating arrangements of the Worthington engine

For both suction and discharge on all stages Laidlaw patented feather-valves are fitted with a view to insuring freedom from valve trouble. Throughout the discharge the valves are water-jacketed, in order to avoid excessive temperatures and consequent carbonizing of the lubricating oil. With this valve the seat is a cast-iron grid of disc form, the slots forming the air-passage and the bars forming the seat for the valve strips. Seated on top of the grid and covering the slots are these flexible strips of steel, held in place by a second disc-grid, bolted in such a position that its bars coincide with the slots on the first grid. As the bars of the second grid are milled to a concave shape the flexible strips are free to bend upward when pressure comes out of the valves, thus making a passage for the

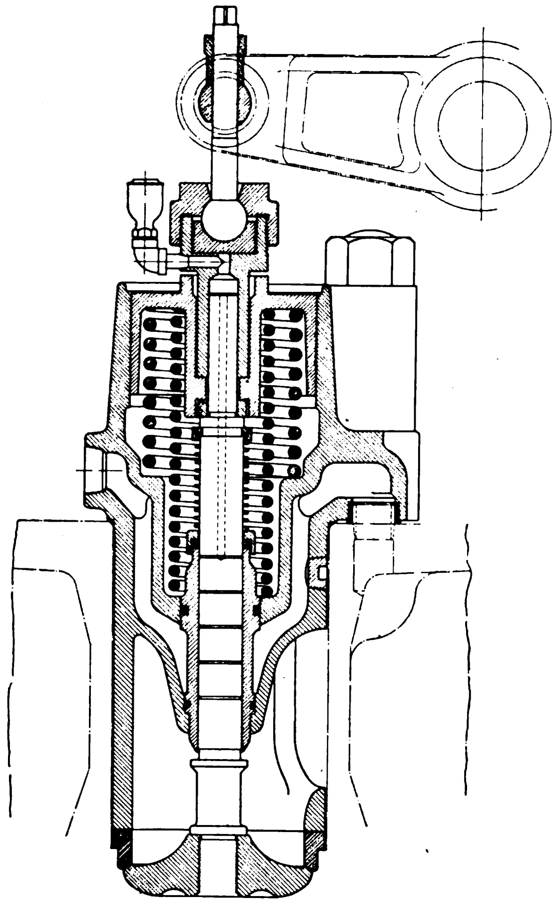


Worthington piston-cooling mechanism. It is one of the most simple systems we have yet seen. Note leather packed pump-piston

air to flow through. The whole valve-unit fits into a cone-shaped opening, and being held in place by a single stud, can be quickly lifted-out for examination or adjustment.

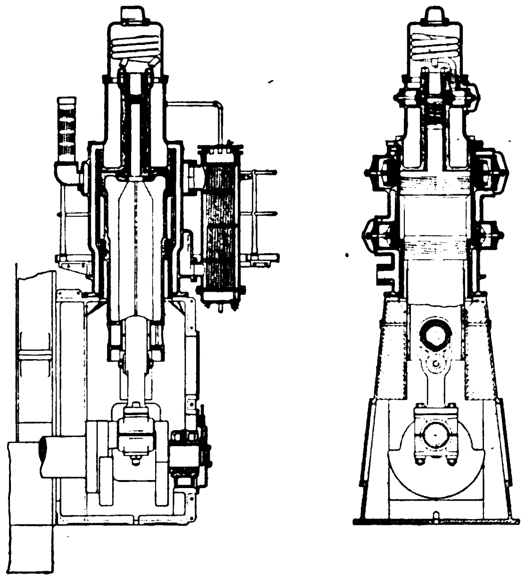
For the purpose of governing the load and speed of the engine, especially when the ship is in a heavy sea, a centrifugal spring-loaded governor is located just forward of the thrust-bearing and is driven from a ring-gear attached to the forward thrust-shaft coupling flange. This governor serves as a safety stop only, cutting off the fuel-oil supply from five of the six cylinders when the speed increases about 10% over normal. This control is omitted from the sixth cylinder in order to prevent the possibility of stalling the engine when the governor acts. The governor acts through reach-rods and a shaft to operate a bar which lifts the rocker-arms beneath the suction-valves of the fuel-measuring pumps, holding the valves open during the entire discharge stroke.

The main control of the engine is by two levers, one for the forward three cylinders and the other for the aft three. These levers



Section of one of the interchangeable Worthington inlet and exhaust valves

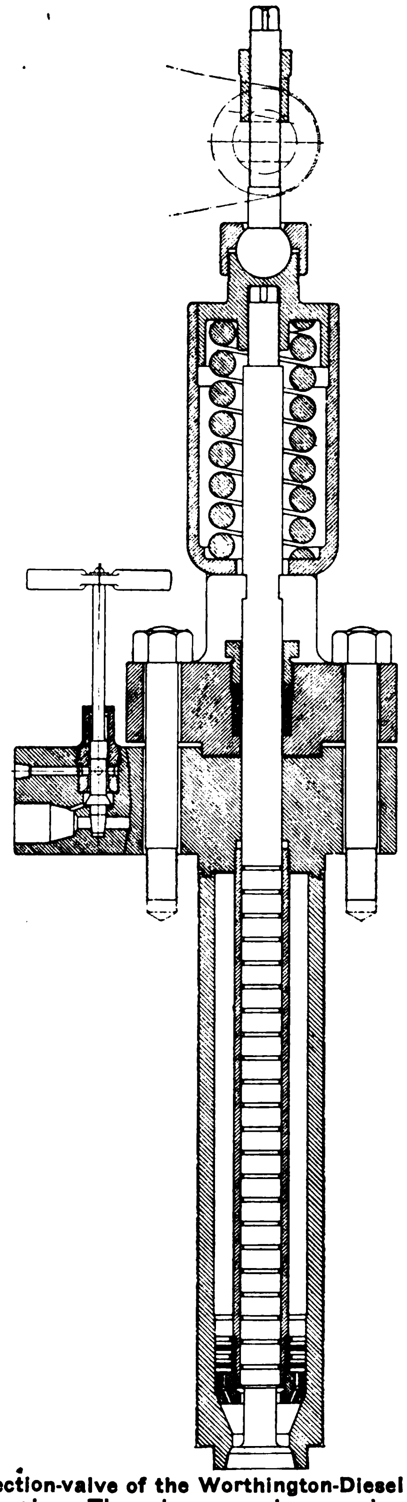
are located side by side at the center of the length of the engine, and are operated from the engine-room floor. The first movement of either lever admits the starting-air, and further movement closes the air and admits the fuel-oil. Continuing the movement increases the amount of oil up to maximum load. Separate control of each three power cylinders make possible a lower minimum speed as by operating on one-half of the cylinders the power developed per cylinder is doubled, insuring regularity in burning of fuel and increasing the flexibilty of the en-



Air-compressor details of the Worthington engine. It is of the three-stage type

gine. For reversing, a lever is located to the left of the main operating-levers and adjacent to the reversing-air cylinder. This lever controls two mushroom-valves which admit air to either end of the reversing-cylinder.

The reversing-cylinder is completely interlocked with the main operating-levers so that it is impossible to shift the reverse-gear when either the starting-air or fuel is on, or start the engine with the reverse-gear off of either ahead or astern position. A bar connected to the air-cylinder piston-rod serves to return the reverse-lever to mid position near the end of the stroke in either direction shutting off the air from the cylinder, and at the same time to release the lock on the main



Injection-valve of the Worthington-Diesel engine. The valve opens downwards

operating-levers permitting of starting of the engine. There is also a valve at the operating-station which controls the main starting-air supply and which is closed when maneuvering is completed.

The main supply-line from the storage-tanks leads to a casing at the operating-station containing two valves each connected to one of the operating-levers and controlling the air to three power-cylinders. From each one of these valves a pipe extends upward and then along the cylinder entablature in each direction, supplying the air to the operating-valves. From the latter separate pipes lead to the cylinder-heads where suit-

able check-valves are located. The standard air-pressure for starting and maneuvering is 375 lbs. per square inch, but the engine can be started on a lower pressure. In fact the temporary storage-tanks in the factory only allow a pressure of 300 lbs.

The piston is of cast-iron with concave-shaped head and is made with a central column extending from the top to the lower face and bearing against the piston-rod. This serves to distribute the stress uniformly and relieves the head from carrying the entire load. The piston-rings are eight in number the first ring being placed as far as possible from the top face in order to remove it from the area of intense heat. Wasson rings of 22 in. diameter are used. The upper end of the piston-rod is formed into a large flange and the piston rests on this flange. The rod is secured to the piston by studs threaded into the piston and fitted with lock-nuts. Cooling-water enters the head at the circumference, flows through a cored passage to the inside of the center columns. It rises in the center column, flows out through cored passages to the main body of the piston, filling this body and spreading out uniformly against the under surface of the piston head.

Piston-cooling has been very carefully studied. At a point near where the main inlet-pipe joins the air-compressor jacket a 3 in. line branches and runs the length of the engine on outboard side. Opposite each working-cylinder a branch from this line joins the piston-cooling inlet-pipe and the water passes up through a telescopic-tube to the piston. The return from the piston is through a twin telescopic-tube and out through a pipe to the piston-cooling return-water header. Forming a part of the lower section of each pair of telescopic-tubes is a large air-chamber which removes pulsations caused by the pumping action of the telescopic-tubes. At the lower end of the reciprocating part of each tube are two leather cup washers, forming a piston and preventing leakage. At the point where the telescopic-tubes pass through the entablature a closely-fitting splash-hood is provided that will prevent any drops of water being thrown up onto the cylinder wall or piston-rod. It will be noted from the sketch that there is no stuffing-box at the joint of the telescopic-tubes by the piston, so danger of wear or breaks is eliminated.

To-day a number of engine-builders are using built-up crank-shafts because of the lower cost than a solid-forging. The Worthington crankshaft is a built-up shaft in two sections, each section having three cranks. It is of open-hearth forged-steel. Each crank-pin is forged integral with two webs.

Forced oil-feed is used for lubricating all of the principal bearing. A motor-driven, independent pump draws the oil from a pump tank below the engine-room floor and discharges it at 15 lbs. pressure into a fore and aft 3 in. header on outboard side of engine at the level of the main-bearings. Opposite each main-bearing a branch pipe passes through the main-bearing cap. From the bearing the oil passes into the axial-hole in the crankshaft through radial-holes in the shaft which register with a circumferential groove in the bearing. It passes from the axial-hole in the shaft through a hole in the crank-web into an axial-hole in the crank-pin. From this axial-hole it is conveyed through radial-holes to a circumferential groove in the crank-pin bearing. An axial-hole in the connecting-rod enables the oil to flow up through the rod to the crosshead-pin bearing and crosshead-guide.

Lubricating-oil is supplied to the power-cylinders, compressor-cylinders and auxiliary exhaust-valves by Richardson-Phenix force-feed lubricators placed on the A-frames on inboard side of engine in a position easily accessible from the engine-room floor, and operated by gears from the cam-shaft. Each power-cylinder has two separate feeds placed diametrically opposite and timed so that oil enters on the suction stroke. The cam-shaft bearings are fitted with chain oilers running in an oil-bath. Other minor bearings are fitted with Lunkenheimer oil-cups.

It is now the policy of the majority of marine Diesel-engine manufacturers to adopt the Kingsbury type of thrust-block, as a considerable amount of space is thereby saved and, generally speaking, this thrust-block is more efficient than the old horse-shoe thrust which is heavy and occupies far too much valuable space in the ship. With the Worthington engine the Kingsbury thrust-block has been adopted. Owing to great pressure on space we are obliged to leave discussion of other features of this engine until a later date.

The Economic Ship

Necessity for Research Work—Importance of the Diesel Oil-Engine

By SIR J. H. BILES, F.R.S.

THE economic ship, like the economic anything else, is successfully economic only under certain conditions. If the conditions change partly or wholly, the success of the operation may be changed to failure.

The solution of such a complex problem as the most profitable ship to fulfil a given set of conditions is one for a research department of the shipping of a nation. The supply of university graduates is increasing, and if labor continues to demand a larger and larger share of the comforts and earnings of shipping capital, the capitalists should see that more and more research is undertaken to improve the economic result.

The total cargo delivered per annum naturally depends on the distance the cargo is carried and the amount carried per voyage, and may be expressed as so many ton-miles per annum. If money can be spent on the production of the ship which will more than repay the extra interest, insurance and depreciation by increased ton-mileage, cheapness of production may not be economical. By a ton-mile is here meant a ton of cargo delivered in port after having been moved a mile between ports.

The first cost of a ship in relation to the total deadweight carried is frequently quoted as a measure of economical first cost. All other things being equal, it is; but they seldom are. The total deadweight carried includes the weight of the fuel and consumable stores. The total deadweight carrying of a ship is the difference between the load displacement and the weight of the structure—the light weight of the ship, as it is technically termed. The light weight includes weight of the machinery; the power of the machinery for a given size of ship is dependent upon the form of the ship.

For improved economic results, revenue must be increased and operating expenses reduced. The source of revenue is cargo-carrying. This can be increased by increasing the amount of cargo carried per annum for a given first cost of ship. This involves increased cargo-carrying per ton of displacement. Increased cargo-carrying may be obtained by lighter structure of hull, by reduced weight of fuel and machinery. It also involves more rapid discharging and loading of cargo, and reduced congestion at ports. For a 4,000-mile run the time spent in port used to be about one-half the time spent at sea in an 8,000-ton dead-weight ship. Since pre-war times the detention in port has more than equalled the time at sea. One-fourth fewer voyages can be made per annum under these latter conditions of ports, and the corresponding increase of freight rates is one-third.

The cost of coal represented one-fourth of the total running expenses and one-tenth of the weight of the paying cargo. The use of oil as fuel instead of coal would reduce this weight by at least one third and increase the weight of paying cargo by about 3½ per cent. The cost of fuel would be probably no more in the case of oil, if credit is given for the increased cargo-carrying, provided that the oil did not cost more than twice the cost of the coal per ton. **But oil used as a fuel is not used to the best advantage. By the adoption of the Diesel-engine the oil can be used to so much greater advantage that the reduction of weight of oil carried from that of coal would be three-fourths and the gain in paying cargo would be about 8 per cent.**, while the oil might cost five times as much per ton and yet yield the same profit. As oil can be produced and sold at much lower rates relatively to coal than five times the cost per ton, it seems that **the economic ship should have Diesel-engines instead of either coal or oil fired steam engines.**
—*The London "Times."*

ALEXANDER STEPHEN & SONS ACQUIRE SULZER-DIESEL LICENSE

Recently, a number of British shipbuilding companies have, as stated in these columns, acquired a Sulzer two-cycle Diesel-engine constructional license. The latest is Alexander Stephen & Sons, Ltd., Linthouse, Govan, Glasgow, Scotland.

U. S. NAVY BUILDING TWELVE 3,000 SHAFT H.P. DIESEL-ENGINES

It is reported that work is just about to be commenced on the construction of twelve 3,000 shaft h.p. Augsburg type four-cycle reversible Diesel engines for submarines at the Brooklyn Navy Yard. They will form six 6,000 b.h.p. twin-screw sets for 1,200-tons craft.

YARROWS ADOPT POLAR-DIESEL LICENSE

In our Editorial for May we referred to Yarrow, Ltd., negotiating for another marine Diesel-engine license, their M. A. N. agreement having expired. They have acquired a license from the Atlas Diesels Motorer of Stockholm, Sweden, and will build a two-cycle Diesel engine, as well as a four-cycle model along the lines of the McIntosh & Seymour-Polar engine.

BIG AMERICAN MOTORSHIP FLEET TO BE BUILT

Arrangements are now being made between an important American shipbuilding yard and a well-known Diesel-engine building company near the East Coast for the supply of a large number of high-powered four-cycle type Diesel-engines for installation in a fleet of motorships very shortly to be built for one of the greatest organizations in the United States. The deal—if closed—will involve a vast sum of money, and will mean an extension of the already big Diesel-plant, and will almost fill its capacity for a couple of years. We hope to be in the position to announce complete details in our next issue.

Texas Company's New Motorship

"Solitaire," a McIntosh & Seymour Diesel-Engined Bulk-Gasolene Tanker of 6730 Tons Displacement

By the Editor of "MOTORSHIP"

TO a measure it is uncomprehensible to the reasoning of those who know the present successful stage of the motorship that, regardless of the splendid results of over 95% of the economical Diesel-engines in large European tankers and freighters, several of our leading domestic oil companies have side-stepped giving any moral or substantial assistance whatever to the oil-engine industry in developing internal-combustion propelling power, and have yet to order their first motorship. In some cases they do not even seem willing to discuss the merits of Diesel power with the representatives of our manufacturers, who more often than not are received with indifferent or begrudging attention by those who should be their best friends.

In view of the great benefits which oil companies must ultimately derive from a large fleet of American Diesel-ships in operation on the high-seas and from their operation in their own oil-carrying fleets, it is almost inconceivable that the attitude of a few should be so non-progressive, lethargic, and, unfortunately, even antagonistic. No one regrets more than ourselves that this is the case, and a typical example was drawn to our attention a few days ago. As to the success of the motorship the evidence is, as Admiral Coontz says, "all in one way," while Admiral Benson goes a step farther and declares that American ships can't compete with foreign vessels on any other basis. Secretary of Commerce, J. W. Alexander; ex-Secretary of Commerce Redfield; ex-Chairmen of the Shipping Board, Edward Hurley and William Denman; Representative G. W. Edmonds; Senator Arthur Capper, and many other public men all endorse our views that motorships are of the most vital importance to the success of America's mercantile marine. Yet in the face of indisputable evidences of the success of the Diesel-engine drive, several of our leading oil companies are still calmly indifferent to the existence of such power and serenely continue with the building of wasteful and uneconomical steam-propelled tankers.

Were the Diesel-engine not as successful as it actually is, our oil-companies would have an even greater incentive to encourage its speedy perfection and adoption; for, it is obvious that America cannot successfully own and operate a great fleet of coal-burning or oil-fired steam-driven freighters in the face of world-wide competition, because without the enormous economy benefits from the use of the Diesel-engine, the operating costs will be too high, except in a few special cases, without heavy Federal subsidies which most men are anxious to avoid.

Officials of some of the oil-companies raise the question of engine-room personnel as being the chief factor in preventing their ordering motorships, but that, of course, has only a partial stratum of truth in it, and is by no means so serious as believed. It is only necessary to pick out several of their best steam men and send them to the factory while the Diesel-engines are being built, or to secure navy-trained submarine Diesel-engineers, many of whom are available today, and send them to the engine factory for a few months.

We understand that the reason why one well-known oil-company has not ordered Diesel-driven tankers up-to-date is that their

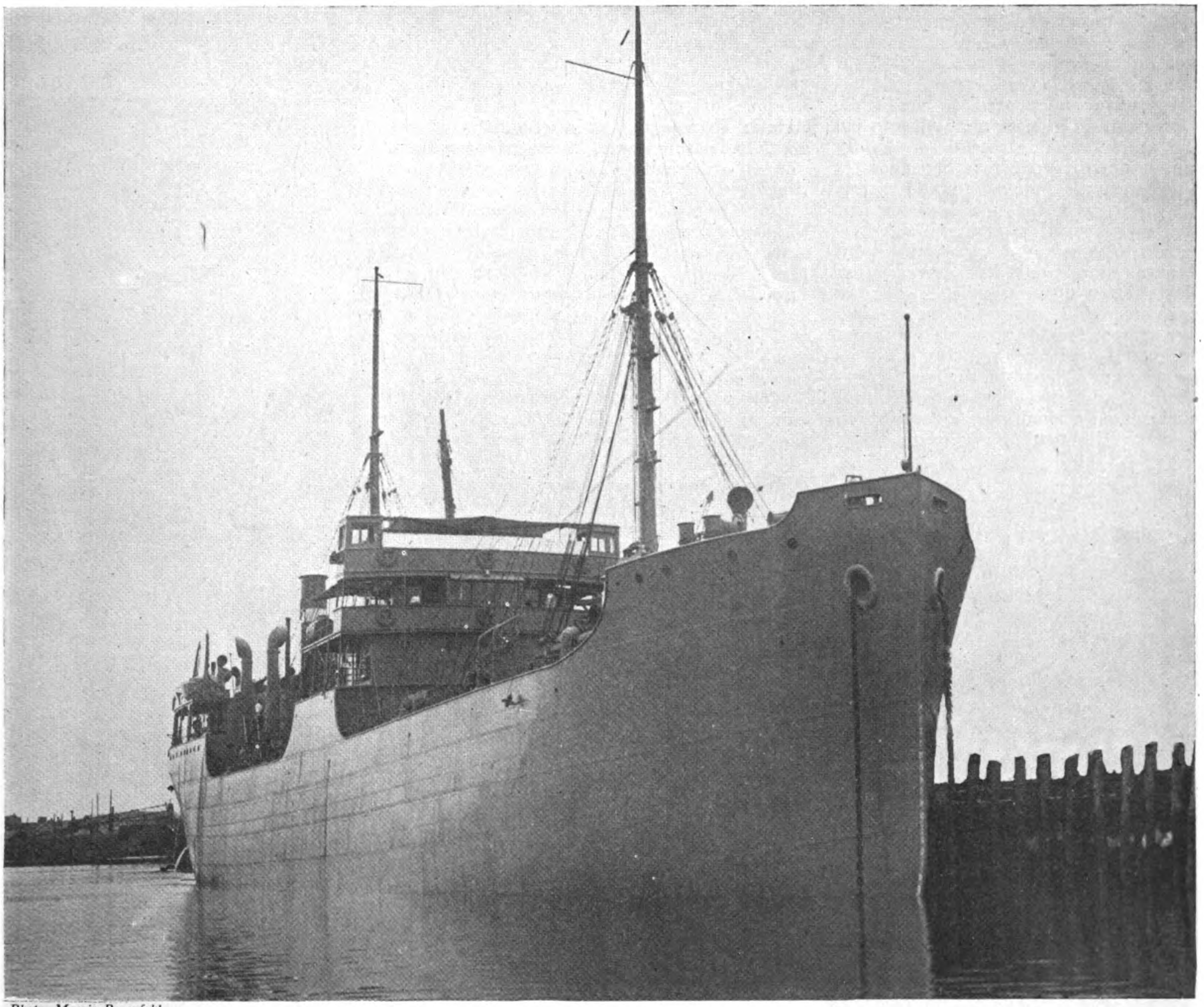


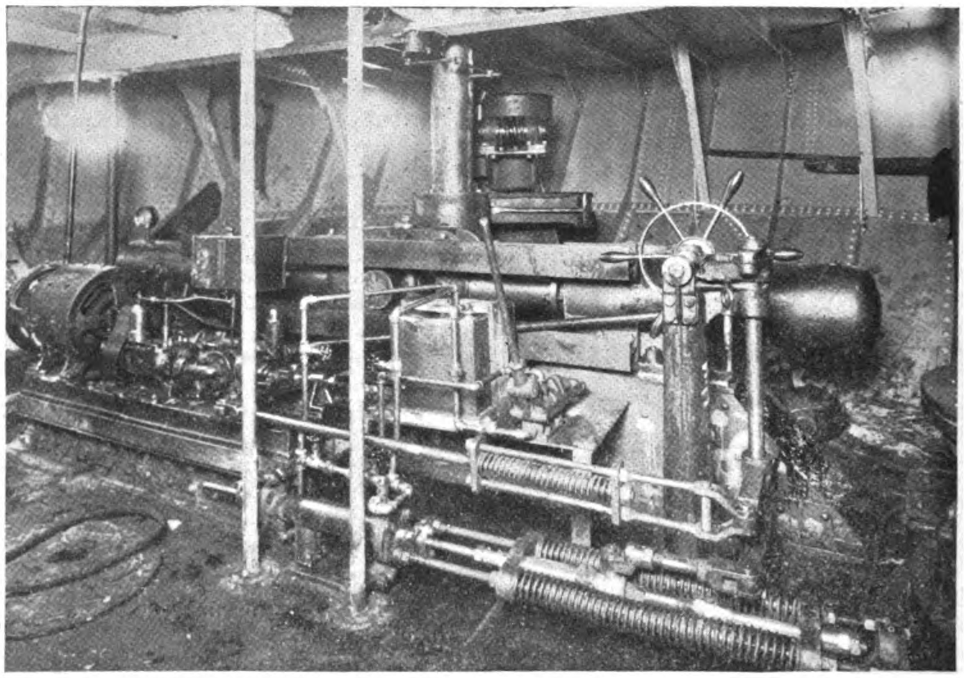
Photo. Morris Rosenfeld

The new American 4,500 tons d.w.c. motorship "Solitaire" owned by the Texas Co. of New York. She is propelled by twin 640 i.h.p. McIntosh & Seymour Diesel-engines

vessels are transporting very heavy-oil on short hauls and that it would mean a large auxiliary boiler installation in order to provide sufficient heat to render the oil to a condition whereby it can be freely pumped. However, they are very much interested and believe in the Diesel system of propulsion and probably will use this type of power for some new ships which they will build for trans-ocean services.

It is interesting to note that all those European shipowners who are building tankships in order to provide their own motor and steam vessels with fuel-oil, are using Diesel-engines for propelling the same. This means it will be possible for them to supply fuel storage-tanks at their home port with bunker-oil at the lowest possible rate, the cost of transportation being much lower than the cost of transporting the same oil in the steam-driven tankers owned by American oil-companies. All the oil they need will not be purchased from American companies, but much of it will be secured from the oil interests of other nations. Therefore, by not utilizing Diesel-driven tankers and so lowering the present very high cost of oil-fuel in Europe, American oil-companies will soon lose a certain quantity of fuel-oil orders.

We are glad to say that this indifferent attitude only applies to a few of the leading American oil-companies. Nevertheless, several—although not all—of those who have lent a hand to the development of the new industry have proceeded—we may as well be frank—in a sufficiently cautious manner to make the oil-engine industry advise us that it feels somewhat discouraged. Apparently they have endeavored to make the money expended in pioneer motorships yield a fairly quick profit, instead of boldly and broad-mindedly appropriating about a million dollars from their profits and wiping the same off their books in the interests of scientific research and commercial development. Part of such monies could be spent in the laboratory and part in the production of an installation of marine Diesel-engines of higher power than any yet in the services of foreign competitors. Appropriations from the different oil-companies possibly could be pooled and turned over to a development association in order that developments could be carried out on a much greater scale than could be attained abroad. Shipowners should



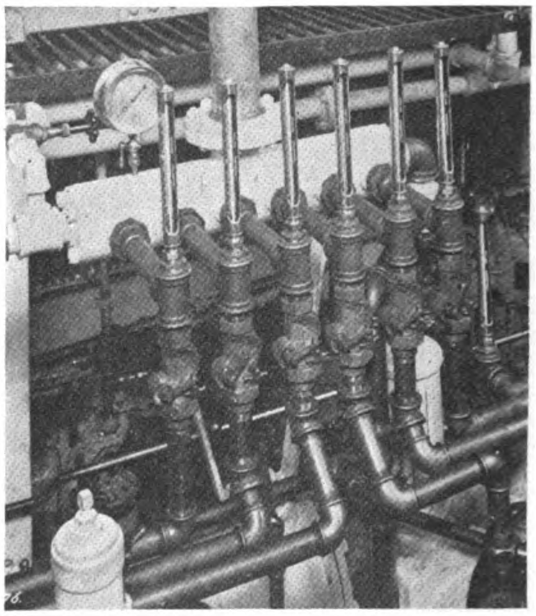
View in after end of ship's main deck, showing Hyde hydro-electric steering-gear

work in with the oil-companies, and bear their share of the expense, as they, too, will benefit from the results.

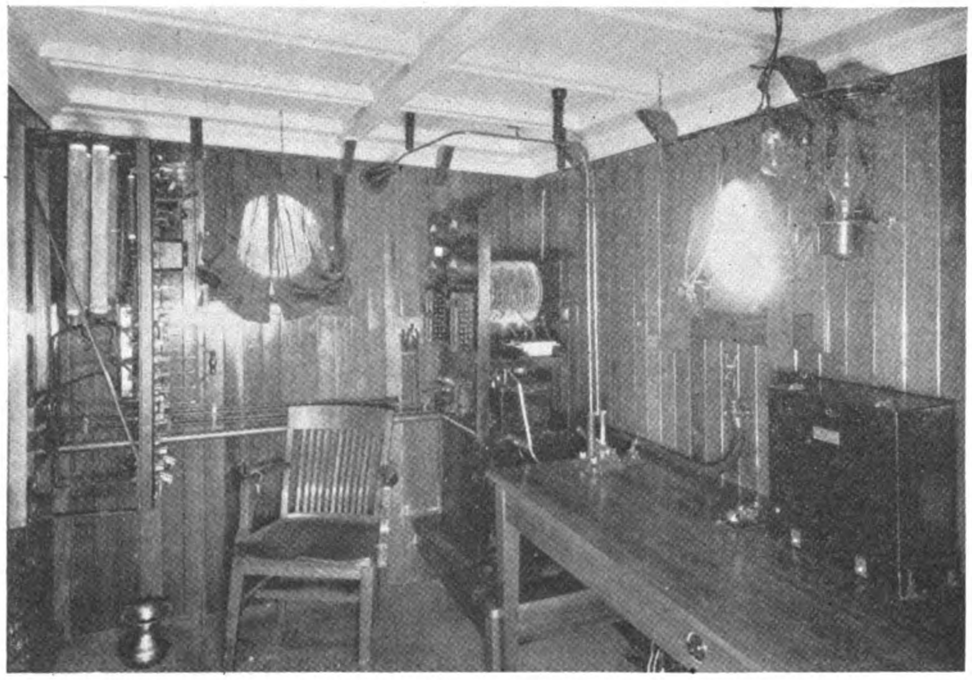
America is the great oil country, and so it is the oil companies that should do their share of this great and even noble work. While immediate financial returns may not be realized, the old story of casting bread upon the waters would surely apply in this case.

We cannot very well overlook the large number of big motorships built by the Asiatic Petroleum Co. of London, or the eight 10,250 tons d.w.c. Diesel-driven tankers now on order with Vickers from the Anglo-American Oil Co., and at the early efforts of the German-American Petroleum Co., also the many Lane & McAndrew motor tankers, and the vast Nobel Diesel-propelled tank fleet. In view of what these European oil-companies have done to assist Diesel builders, our remarks are really very fair and mild. The Standard Oil Co., too, has done much to assist the Diesel engine movement, we are glad to say.

It is with considerable pleasure that we can place upon record the fact that during the last several years The Texas Company, of 17 Battery Place, New York, has given concrete evidence that its management is now fully alive to the arrival of the motorship and that its development means much to them as an oil-company, and they now have three Diesel-driven tankers of small and moderate size in regular operation which they have built at their own shipyard, and have converted one larger sailing-ship to motor power.

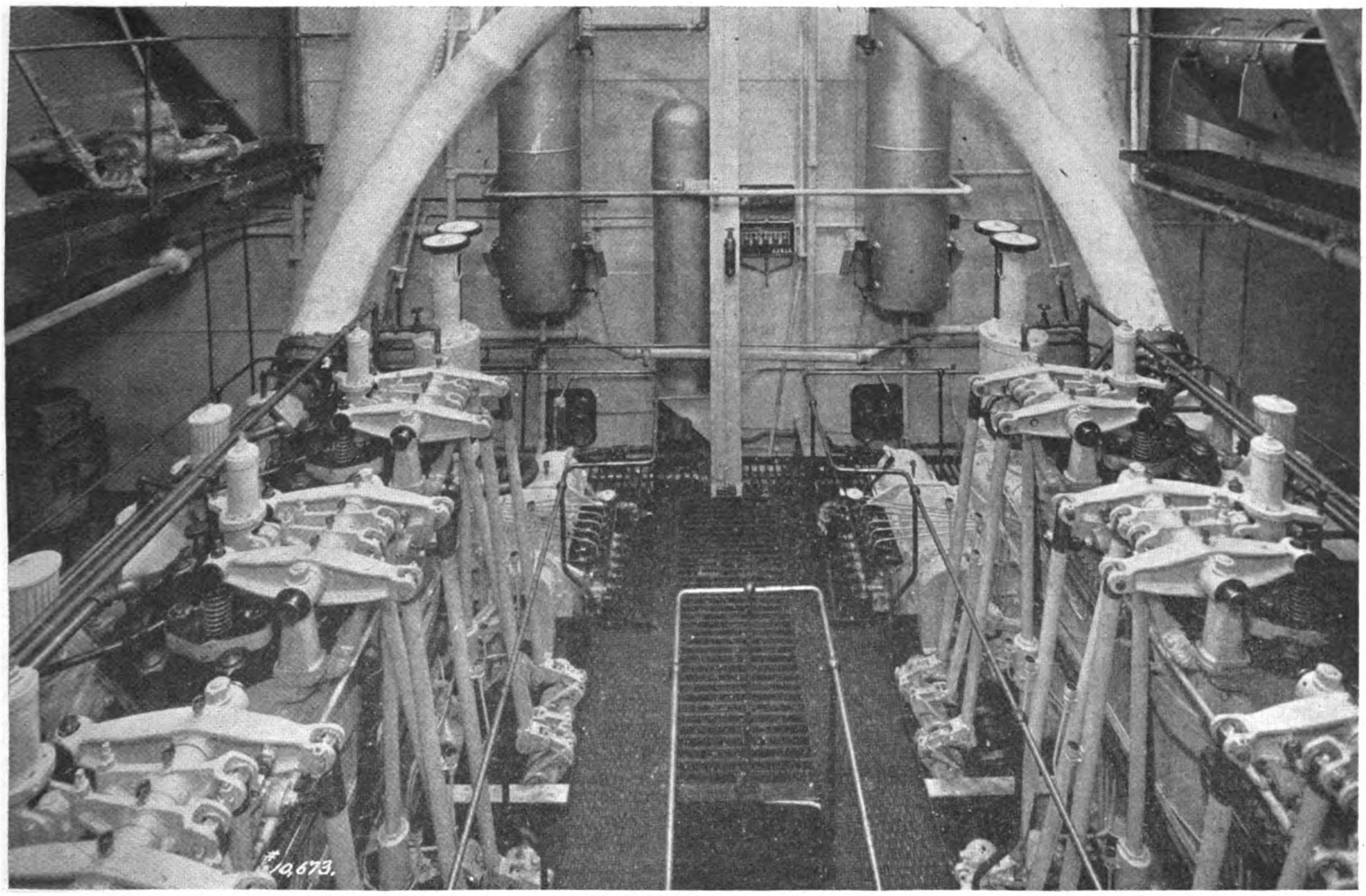


Port main engine, looking to port, showing Tageeabus sight-flow indicators and thermometers on cylinder-jacket cooling-water discharge manifold

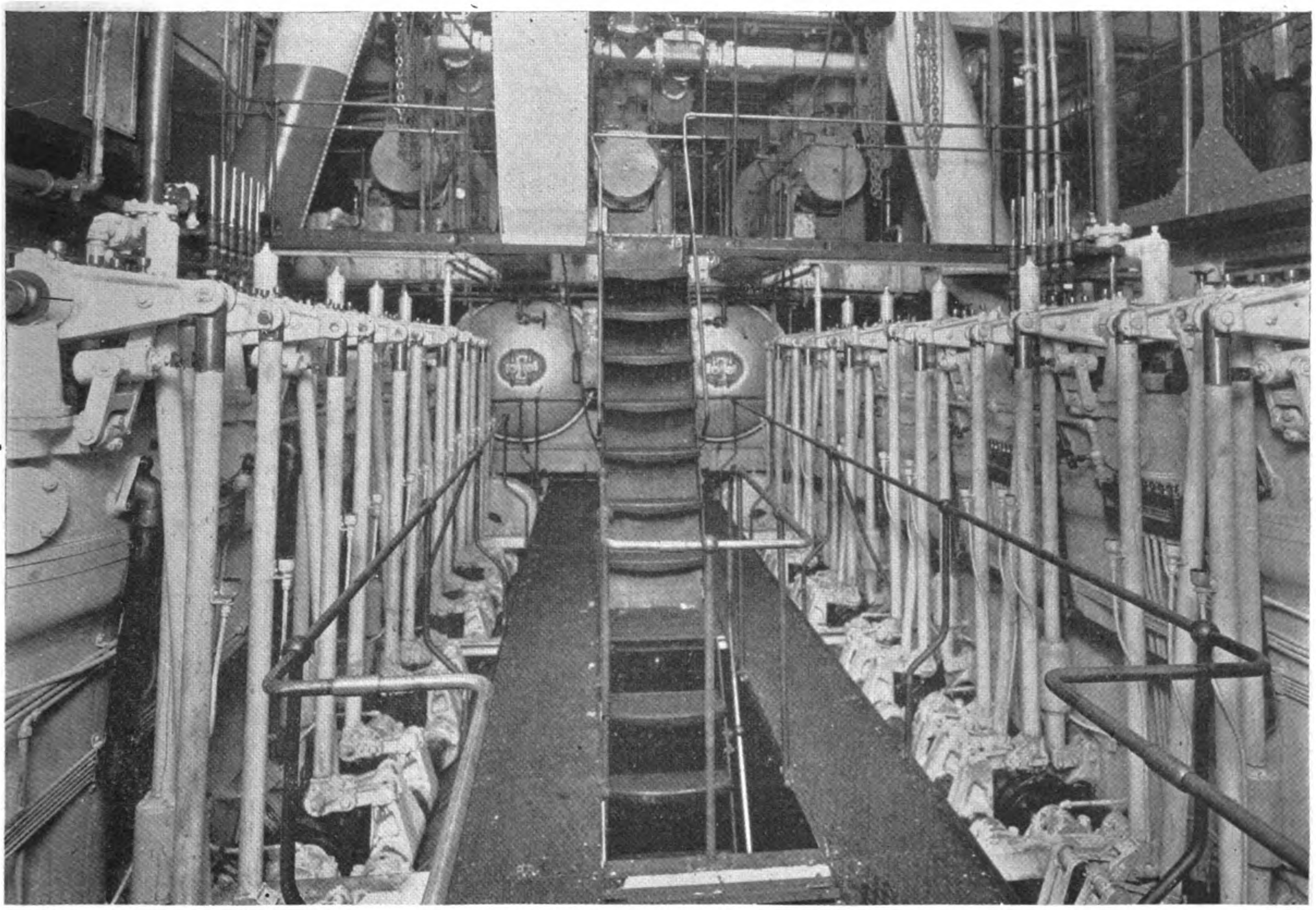


Wireless-room showing Independent Co.'s transmitting and receiving sets. Every modern motorship carries a complete wirelesss equipment

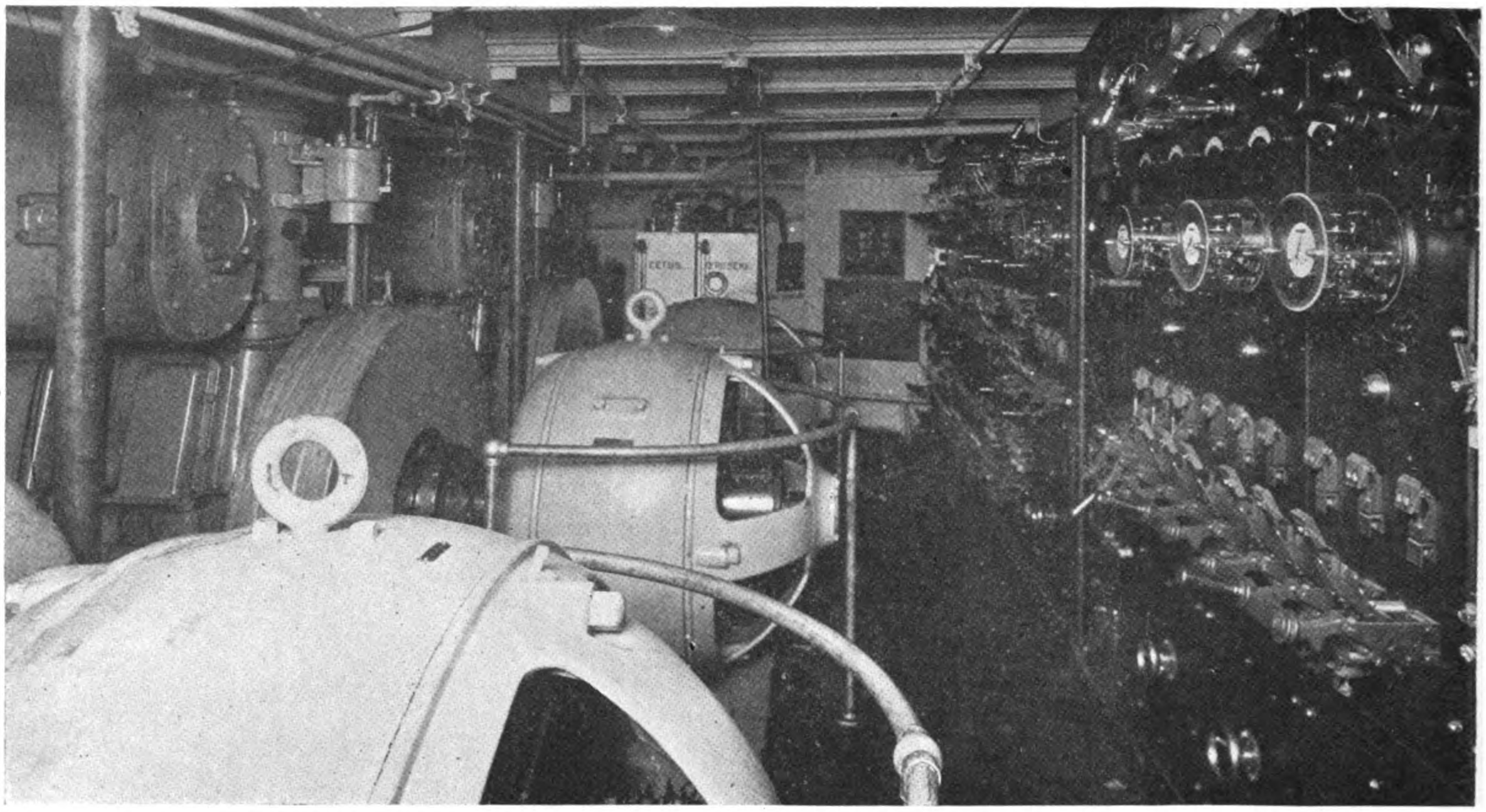
Their newest motorship, a 4,675 tons d.w.c. tanker, quite recently ran her trials and maiden voyage, and through their courtesy we had the pleasure of inspecting her a few days prior to her trials. The "Solitaire," as she is named was launched 100% complete from the yard of The Texas Steamship Company, Bath, Maine, a subsidiary of The Texas Company, on April 3rd, 1920. She left Bath on April 19th and arrived at Port Arthur, Texas, on April 30th. Should she prove as successful as anticipated, we venture to believe that Diesel-engines will be installed in some or all of the future large tankers built at this plant. We have no doubt but that she will be very successful, as she is a splendid craft and is propelled by a pair of the same make of Diesel-engines as



View of the "Solitaire's" engine-room from after dynamo flat, looking forward and down on main McIntosh & Seymour Diesel-engines



Engine-room of the "Solitaire" looking aft showing the three Fairbanks Morse oil-engine electric generating-sets on the 'tween deck flats in the background. The valve and reversing mechanism can plainly be seen on the twin 640 i.h.p. McIntosh & Seymour Diesel-type main engines

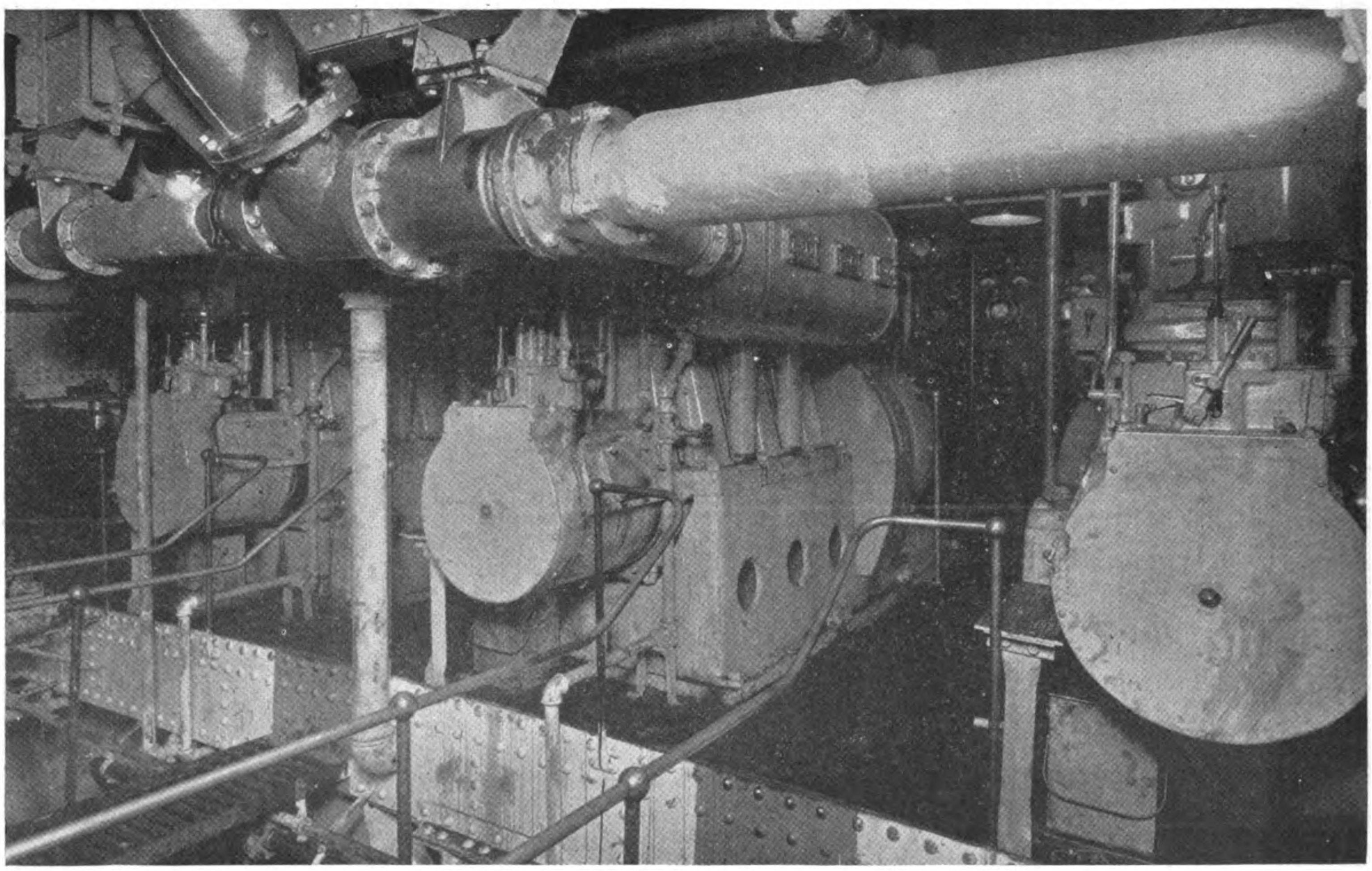


The three Fairbanks-Morse 45 K.W. generating-sets and the switchboard of the motorship "Solitaire"

are installed in the single-screw tanker "Bayonne" of the Vacuum Oil Co., which has made over 50 voyages without a hitch. Also the same make of engines are fitted in two small single-screw tank-boats built by The Texas Steamship Co., for the account of The Texas Company. So we anticipate that it will not be long before motorships of substantial size are in the service of this important oil company.

The "Solitaire" is a twin-screw steel ship and has the following dimensions:

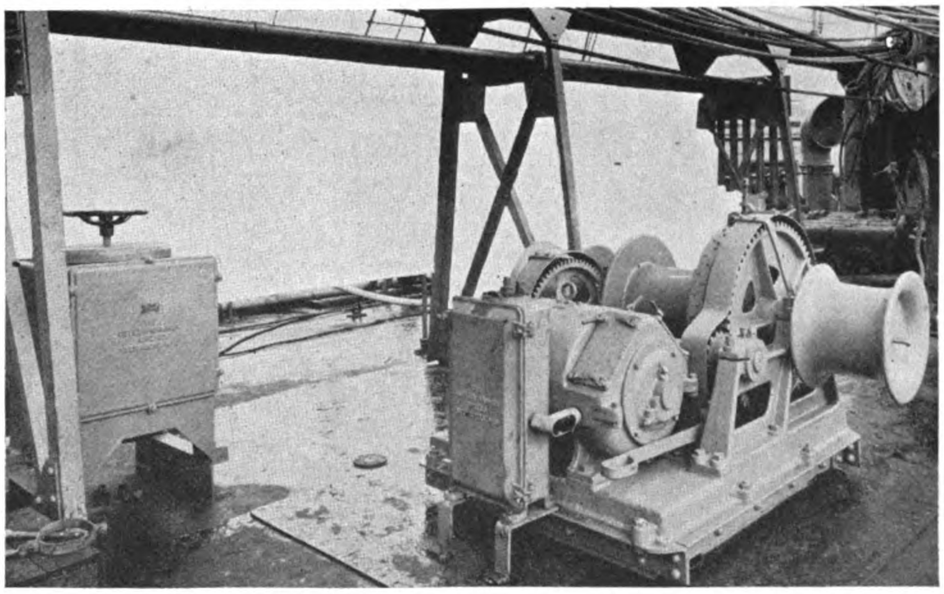
Displacement (loaded)....................6,730 tons
Cargo capacity of holds (not incl'd bunkers).4,300 tons
Deadweight capacity.....................4,675 tons
Fue capacity (maximum)......3,000 bbls. (430 tons)
Fuel capacity (normal).........1,600 bbls. (230 tons)
Cruising radius (maximum).................80 days
Actual daily fuel consumption (for all purposes)...................38 bbls. (1/4 tons)
Lubricating oil (daily consumption)........10 gallons
Fuel-consumption in port (daily)......7 bbls. (1 ton)
Loaded speed (designed)....................9 knots
Trial speed (actual).......................9.18 knots
Power (indicated)........................1,280 h.p.
Power (shaft)...........................1,000 h.p.
Engine-speed............................185 r.p.m.
Length (o.a.)..............................328 ft.
Length (b.p.)..............................315 ft.
Breadth (moulded).....................43 ft. 6 in.
Depth (moulded).......................27 ft. 6 in.
Loaded draught (mean).................22 ft. 8 in.
Weight of fresh water.........................25 tons
Weight of main engines....................150 tons
Total engine-room machinery weight, including plumb ng, deck-piping, refr gerating-set, cargo and oil systems, and propellers, and shafting..........260 long tons
Propellers (twin)...7 ft. 11 in. diam. by 6ft. 4 in. pitch
Length of machinery space (proper).......... 31 ft.
Length of machinery space (bulkhead to bulkhead)....................................41 ft.
Number of engine-room crew.................13 men
Type of auxiliaries....Surface-ignition driven electric
Make of propelling engines.....McIntosh & Seymour
Make of auxiliary oil engines........Fairbanks-Morse



Three 75 b.h.p. Fairbanks Morse surface-ignition oil-engines to the after ends of which are coupled the 45 K.W. generators illustrated above

Attention of shipowners and shipbuilders is drawn to the large net-cargo-capacity for the amount of steel in the hull. The loaded displacement is 6,730 tons, and of this 4,255 tons is represented by bulk-oil cargo, 230 tons fuel (36 days supply), 260 machinery and 30 tons stores, and the balance of 1,955 tons for the hull and all the remaining equipment and fittings of the ship.

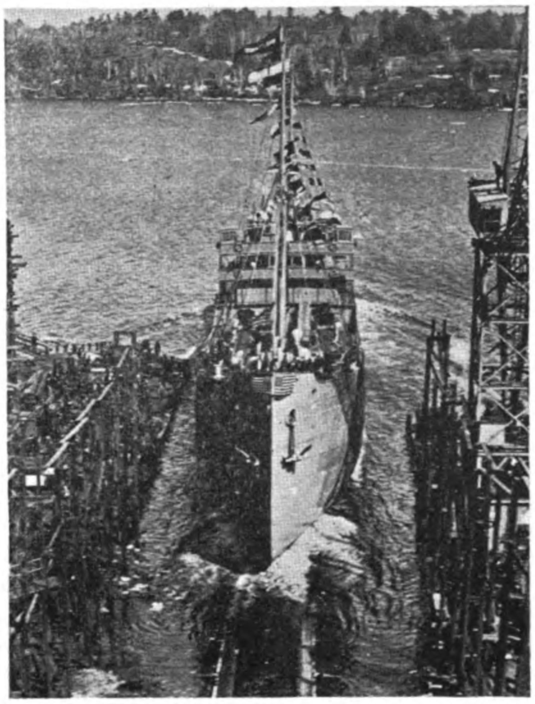
It will be obvious to any shipping man that the "Solitaire" carries at least 10% more cargo than an oil-fired steamer of similar size and similar quantity of structural steel in the hull, so that even if the total cost of the motor-vessel is a little higher, **the price per cargo-ton is a little less than that of the steamship, which is contrary to the usual belief.** In this connection the term deadweight capacity means nothing and is obsolete for making comparisons between steam and Diesel-driven ships. Many shipowners have mislead themselves over the "cost-of-motorships" question purely through figuring out the prices as being so much per deadweight ton as is customary when ordering steamers.



The Hyde electric-winch on the "Solitaire," showing Diehl electric motor and Cutler-Hammer control

We cannot lay too much stress upon the fact that a ship should be purchased at "so much per net-cargo-ton, and **not** per deadweight ton. With a steamer the amount of cargo carried (and it is to carry cargo that the owner buys the ship) varies according to the distance of the voyage, whereas with a motorship of reasonable size it makes very little difference whether she has to voyage 10,000 miles or 20,000 miles because of the extraordinary low fuel-consumption and nil water consumption. Shipowners and their naval architects will do well to take this into deeper consideration than they have hitherto done.

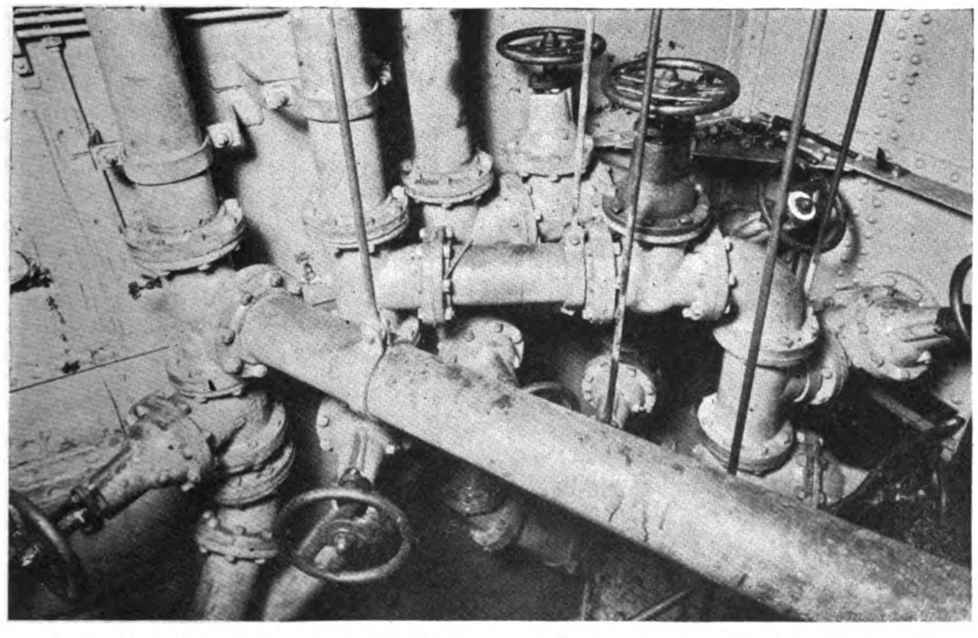
In addition to the foregoing advantageous feature of the "Solitaire" there must be a great saving of fuel, as the daily consumption of the "Solitaire" for all purposes on the maiden voyage, ballasted deep, was only thirty-eight (38) barrels of oil per day, the ship averaging 8.17 knots from Bath to Port Arthur, there being a head wind and sea for five days. When better weather conditions were encountered the speed increased to 9.33 knots. It is well known that a head-sea usually increases the daily consumption of fuel.



The "Solitaire" just entering the water at Bath, Maine

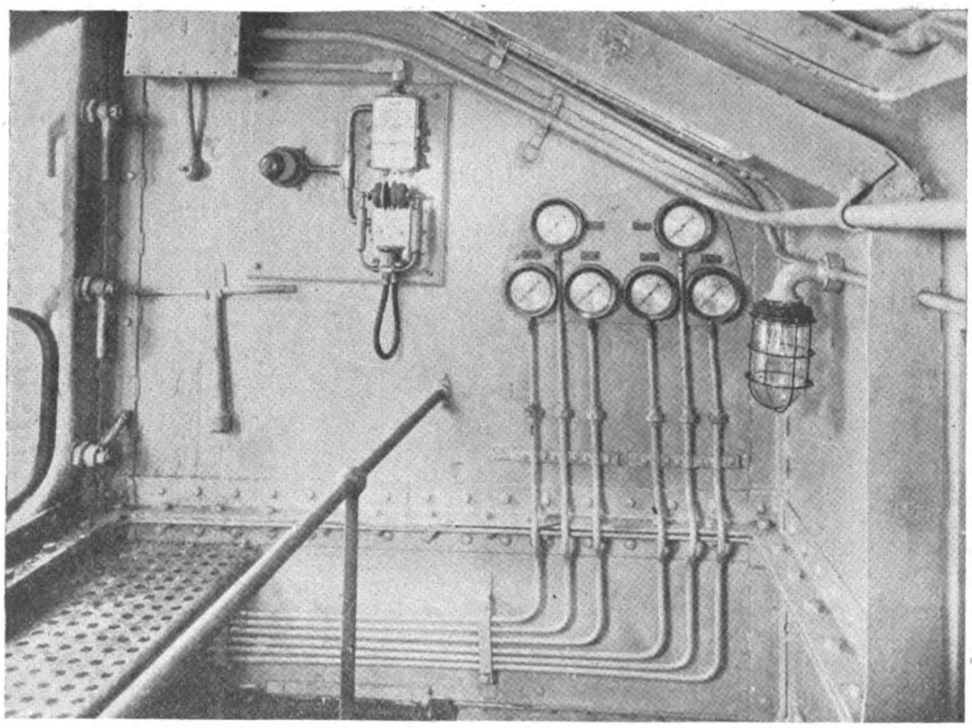
For a similar average speed a steamship of the same displacement would use not less than 115 barrels of oil-fuel per day, while a steamship of the same **net-cargo-capacity** would burn 125 barrels (18 tons), or if coal burning, 35 to 40 tons—according to the distance of the voyage. This perhaps is difficult to believe, but can be checked-up by obtaining actual figures from vessels in service. We have to bear in mind that the net-cargo-capacity of a coal-burner or oil-fired steamer is very much limited by the distance of the voyage, so to lift the same net-cargo as the "Solitaire" on a voyage of say 3,500 miles, the hull of a steamer would have to be 10% or 12% larger and the engine-power and fuel-consumption equally greater. We wonder how many naval-architects and shipbuilders have pointed out these things to shipowners.

The motorship "Solitaire" is propelled by twin six-cylinder trunk-piston four-cycle type, direct-reversible, single-acting McIntosh & Seymour Diesel engines, having a cylinder bore of 16 in. by a piston stroke of 28 in., and each develops 640 I.H.P. (500 shaft h.p.) at 185 revolutions per minute, turning 7 ft. 11 in. by 6 ft. 4 in. cast-iron Trout propellers. This power, on her maiden voyage, gave her an average speed of 8.17 knots and a trial speed of 9.18 knots over the Rockland Navy course in heavy sea fully loaded. We presume that bronze propellers would increase the average speed from 1/4 to 1/2 knot. The installation of the machinery was carried out under the supervision of Mr. L. B. Jackson, plant-engineer, and the ship was designed by and built under the supervision of Mr. George B. Drake, general manager and naval architect of the yard. It is our opinion that in many ways they can be highly pleased with their work, as she is a well-built craft, and should prove a credit to The Texas Co.'s fleet, much attention having been paid to details and to the comfort of the officers, engineers and crew.

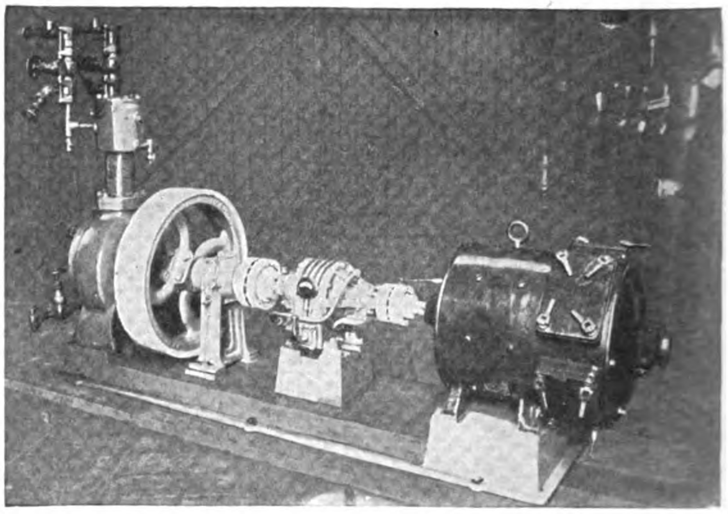


On the "Solitaire" there are about 300 brass and gunmetal valves from 1/4 in. to 7 in. diameter. The above illustration shows a group of valves made by the American Car & Foundry Co., Berwick, Pa., and installed in a corner of the motorship "Solitaire's" engine-room. In the motorship industry there is a splendid market for valve manufacturers

We would have liked to have seen greater power installed in this ship, and her average speed increased to 10 knots. This would have reduced her cargo-capacity by about 125 tons, but may have increased her annual carrying-capacity because of the better speed. However, we gathered from The Texas Company's officials that on the particular route that she is serving, namely from Port



Showing Magnavox loud-speaking telephone, and gauges in pump-room, found to be most useful on the motorship "Solitaire"



One of the Brunswick compressors of the refrigerator of the motorship "Solitaire." The electric motor is a Diehl

Arthur, Tex., to Charleston, S. C., no particular benefits would have been derived from increasing the designed speed, whereas the first cost would have been higher and the operating expenses would have been a little greater. Were she in overseas service the advantages and advisability of higher power and better speed would have been more apparent. We mention the power-and-speed question because many American-built motorships have been partial failures purely through underpowering, and we are anxious that shipowners shall not repeat past mistakes.

All the auxiliary machinery of the ship is electrically operated, even the officers' cabins being electrically heated. Power for generating the current is provided by Fairbanks-Morse two-cycle type surface-ignition heavy-oil engines.

The engine-room of the ship is aft, and only occupies a moderate space. This does not include the pump-room which is forward in a small special compartment bulk-headed off. At the after end of the engine-room there is a 'tween deck dynamo flat, and here are installed three 75 b.h.p. Fairbanks-Morse oil-engines coupled to 45 K.W. electric generators of the same make. Also one 30 h.p. Fairbanks-Morse oil-engine driving a 10 K.W. set for port lighting on one end and a 1,200 lbs. Craig air-compressor on the other end for initial starting and injection air.

These furnish current for lighting, engine-room motor-driven auxiliaries (Fairbanks-Morse), the Hyde anchor windlass, Hyde electric-hydraulic steering-gear, electric refrigerating-plant, Hyde electric-winch, electric-siren, pump-room, electric ventilating-fan Fairbanks-Morse motor-driven and the cargo-pumps. Electric-motors other than those by Fairbanks-Morse are by the Diehl Manufacturing Co. of Elizabethport, N. J. The electrical heaters in the cabins, the switch-board and controllers in the engine-room, and the controllers on the deck-winches, etc., are Cutler-Hammer products; but the ampere-meters and watt-meters on the switch-board were supplied by the Sangamo Electric Co. Circuit-meters are of the Cutler Co.'s I.T.E. type. There also are many Crouse-Hind fittings.

Two 45 h.p. Fairbanks-Morse oil-engines are installed on a low level portside flat in the engine-room, coupled to Craig air-compressors for 250-pound starting-air service normally, but which are capable of delivering air at 1,200 pounds pressure if needed.

There is no steam boiler on the ship, but the after quarters for engineers and crew are heated by an ordinary coal-fired hot water heating boiler of the American Radiator Company, such as can be seen in almost any modern American house. As there is no steam, signals are given by a compressed-air whistle; a large electric siren operated by a 5 h.p. motor fitted to the main mast which makes an unusually loud and distinctive noise. It is made by Hendrie & Bolthoff, of Denver, Colo., and is known as the Denver Siren. It has been suggested that a brilliant light might be used in conjunction with this siren, so as to command instant attention both day and night, the light to shine during the period of the blast.

One thing that came to our attention during inspection of this motorship in that manufacturers of valves do not appear to have realized the tremendous amount of business to be obtained from the merchant-motorship field if our publicity columns give any indication of their ideas. On the "Solitaire" there are at least three hundred brass or gun-metal valves ranging from ½ in. to 7 in. These were supplied mainly by two companies; namely, the Lunkenheimer Co. and the American Car & Foundry Co. of Berwick, Pa.

Two types of lubricating oil-filters are installed in the engine-room of this ship; namely, the De Laval and the Richardson-Phenix.

Because of the nature of the cargo, ordinary fire-pumps had to be supplemented by chemical equipment, so throughout all cabins Pyrene fire extinguishers are installed. In the cargo holds there are a number of steel bottles containing carbon-dioxide, the stoppers of which melt at comparatively low temperature. The practice of installing these chemical fire-extinguishers aboard motorships is now becoming general, so manufacturers will do well to utilize our publicity-pages to point out the merits of their particular product.

Magnavox telephones are installed on the bridge, engine-room, pump-room, cabins, etc., and are found to be excellent in noisy places, such as the engine-room of the ship, because of the distinctness with which conversation can be heard. It may be remembered that the Standard Oil Co.'s two new motorships are also having Magnavox telephones.

We referred to the engine-room crew as consisting of 13 men. They are the chief-engineer, three assistant-engineers, three oilers, two wipers, two electricians and two pump men. Very excellent accommodation for the officers, engineers and crew are provided. In fact, the general run of accommodations is better than first-class passengers and crew get on board the average trans-atlantic liner. For the bath-rooms instantaneous hot-water is obtained from electric heaters.

A word or two must be said about the pump-room. All the electric-motors are completely enclosed, and a special motor-driven exhaust ventilating fan induces a constant supply of fresh air through the motors from the atmosphere, so that there is no danger of explosions from sparking at the brushes in the event of the pump-room being full of gases from the cargo handled by the pumps.

There is a complete wireless installation on the ship, installed by the Independent Wireless Telegraph Co. of New York City. The transmitter is a direct coupled 1 K.W. 500-cycle rotary-spark type, so designed as to be extremely efficient and very simple in construction. The motor generator, automatic in control, has a dynamic brake which stops it in twelve seconds. The receiver is of the capacity-coupled type, being 8 in. deep, 14 in. wide and 16 in. high. This equipment will enable the operator to transmit at least three hundred miles and will receive wave lengths up to 7,500 meters at any distance, depending upon the power of the transmitting station. The apparatus is fitted for working on 300 meters, 600 meters and 800 meters, the latter being for obtaining radio compass bearings.

Finally we will refer to the low weight of the propelling machinery and auxiliaries. In some circles it is believed that Diesel machinery weighs much heavier than steam plant, but this is not the actual case, as with most of the 10,000 tons motorships in service there is a saving of a couple of hundred tons in the machinery weights compared with sister steamers. Even with the "Solitaire" there is quite a considerable saving, and—she is of only 4,675 tons d.w.c.

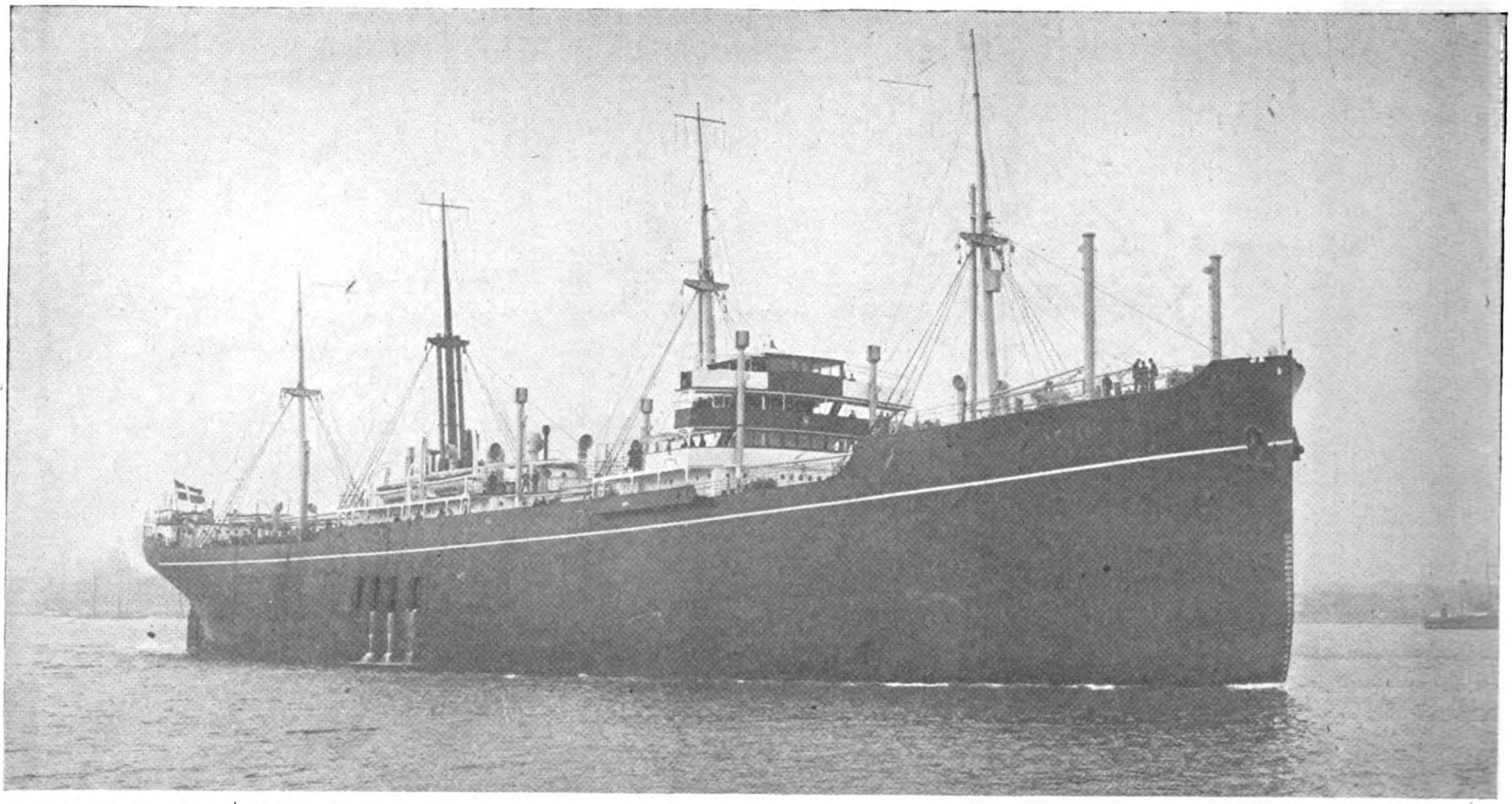
LIST OF OCEAN-GOING MOTORSHIPS WITH BURMEISTER & WAIN DIESEL ENGINES ALREADY PLACED IN SERVICE

BUILT BY BURMEISTER & WAIN AND THEIR LICENSEES (Ships under construction and on order NOT included)

Name of Ship.	Year Completed.	Shipowner.	Shipbuilder.	Length. Ft. Ins.	Breadth. Ft. Ins.	Depth. Ft. Ins.	Draught. Ft. Ins.	D. W. Capacity Tons.	Engine Builders.	Total Ind. Horsepower.	Number Cylinders.	Cylinder Diameter. Inches.	Piston Stroke. Inches.	Engine Revs. per Minute.	Speed in Knots.
Selandia	1912	East Asiatic Co.	Burmeister & Wain	370—0	53—0	30—0	23—6	6800	Burmeister & Wain	2500	8	20.85	28.75	140	10.5
Christian X.	1912	Hamburg-America	"	370—0	53—0	30—0	23—6	6800	"	2500	8	20.85	28.75	140	10.5
Jutlandia	1912	East Asiatic Co.	Barclay Curle	384—0	53—0	30—0	23—6	6800	Barclay Curle	2500	8	20.85	28.75	140	10.5
Suecia	1912	Nordstjernan	Burmeister & Wain	362—0	51—3	25—6	23—1	6550	Burmeister & Wain	2000	8	19.67	26.00	140	10¾
Siam	1913	East Asiatic Co.	"	410—0	55—0	30—6	26—5	9700	"	3000	8	23.23	31.50	125	11¼
Annam	1913	"	"	410—0	55—0	30—6	26—5	9700	"	3000	8	23.23	31.50	125	11¼
Fionia	1913	"	"	395—0	53—0	36—0	24—3	7000	"	4000	6	29.13	43.30	100	13½
California	1913	United Steamship Co.	"	405—0	54—0	35—0	23—3	7250	"	2700	8	21.26	28.75	140	11¼
Pedro Christophersen	1913	North Star Line	"	362—0	51—3	25—6	23—1	6550	"	2000	8	19.68	26.00	140	10¾
Folkvard (ex Bandon)	1914	(Norwegian Gov'ment)	Barclay Curle	330—0	47—3	.....	.....	6000	Harland & Wolff	1670	6	26.37	39.40	115	11
Mississippi	1914	Atlantic Transp. Co.	Harland & Wolff	383—0	50—4	30—8	.....	6500	"	3600	6	26.37	39.40	120	11
*Malakka	1914	East Asiatic Co.	Burmeister & Wain	410—0	55—0	30—6	26—6	9200	Burmeister & Wain	3100	6	24.80	37.80	115	11¼
Tonking	1914	"	"	410—0	55—0	30—6	26—6	9200	"	3100	6	24.80	37.80	115	11¼
Krpr. Gustaf Adolf	1914	North Star Line	"	362—0	51—3	25—6	23—1	6550	"	2000	6	21.26	28.75	140	10¾
Krprss. Margareta	1914	"	"	362—0	51—3	25—6	23—1	6550	"	2000	6	21.26	28.75	140	10¾
Pacific	1914	"	"	362—0	51—3	25—6	23—1	6550	"	2000	6	21.26	28.75	140	10¾
Brazil	1914	Fred. Olsen	Akers Mek. Verkst.	323—0	44—0	26—1	.....	4800	Akers Mek. Verkst.	1500	6	19.68	26.00	140	....
Lidvard (ex Pangan)	1914	(Norwegian Gov'ment)	Barclay Curle	330—0	47—3	.....	.....	6000	Harland & Wolff	1670	6	26.37	39.40	115	....
San Francisco	1915	North Star Line	Burmeister & Wain	362—0	51—3	25—6	23—1	6550	Burmeister & Wain	2000	6	21.26	28.75	140	10¾
Panama	1915	East Asiatic Co.	"	410—0	55—0	30—6	26—5	9200	"	3100	6	24.80	37.80	115	12¼
Australien	1915	"	"	410—0	55—0	30—6	26—5	9200	"	3100	6	24.80	37.80	115	12¼
Landvard (ex Chumpon)	1915	(Norwegian Gov'ment)	Barclay Curle	330—0	47—3	.....	.....	6000	Harland & Wolff	1670	6	26.37	39.40	115	11
Falstria	1915	East Asiatic Co.	Harland & Wolff	381—0	50—0	29—0	.....	6800	"	2250	6	22.04	29.92	140	11
Kangaroo	1915	W. Australian Gov.	Mackie & Thompson	381—0	50—0	29—0	.....	6800	"	2250	6	22.04	29.92	140	11
Glengyle (ex Bostonian)	1915	Glen Line	Harland & Wolff	399—1	52—2	33—9	.....	6300	"	3100	6	24.80	33.46	130	11
*Columbia	1915	East Asiatic Co.	Burmeister & Wain	425—0	55—0	30—6	26—5	9500	Burmeister & Wain	3100	6	24.80	37.80	125	11.2
Chile	1915	"	"	425—0	55—0	30—6	26—5	9500	"	3100	6	24.80	37.80	125	11.2
Bayard	1916	Fred. Olsen	Akers Mek. Verkst.	335—2	48—2	20—5	.....	5000	Akers Mek. Verkst.	1500	6	19.68	26.00	140	10
Oregon	1916	D. F. Dampsk. Selsk.	Burmeister & Wain	405—0	54—0	36—6	25—6	8270	Burmeister & Wain	2800	6	23.23	35.43	140	11
Peru	1916	East Asiatic Co.	"	425—0	55—0	30—6	26—5	9500	"	3100	6	24.80	37.80	125	11.2
George Washington	1916	Fred. Olsen	"	425—0	55—0	30—6	26—5	9500	"	3100	6	24.80	37.80	125	11.2
Glenamoy	1916	Glen Line	Harland & Wolff	436—0	55—3	35—0	.....	10000	Harland & Wolff	3600	6	26.37	39.40	120	11
Valparaiso	1917	North Star Line	Burmeister & Wain	367—0	51—3	25—6	23—2	6550	Burmeister & Wain	2600	6	23.23	35.43	130	11¼
Glenavy	1917	Glen Line	Harland & Wolff	385—1	52—2	30—3	.....	7500	Harland & Wolff	2570	6	....	....	....	11¼
Bullaren	1918	Transatlantic Co.	Gøtaverken	425—0	56—0	38—0	26—0	9400	Gøtaverken	4000	6	29.13	43.30	100	13
Tisnaren	1918	"	"	425—0	56—0	38—0	26—0	9400	"	4000	6	29.13	43.30	100	13
Borgland	1918	Fred. Olsen	Akers Mek. Verkst.	362—0	51—3	25—6	.....	6500	Akers Mek. Verkst.	2100	6	21.26	28.75	150	10¾
Glenartney	1918	Glen Line	Harland & Wolff	435—9	55—3	35—2	.....	10000	Harland & Wolff	3600	6	26.37	39.40	120	11
Glenapp	1918	"	"	450—0	55—6	32—0	24—5	9600	"	6600	8	29.53	43.31	120	15¼
Lima	1918	North Star Line	Burmeister & Wain	367—0	51—3	25—6	23—2	6550	Burmeister & Wain	2600	6	23.23	35.43	130	11¼
*Bonheur	1918	Fred. Olsen	"	425—0	55—0	30—6	26—5	9500	"	3100	6	24.80	37.80	125	11.2
Elmaren	1919	Transatlantic Co.	Gøtaverken	425—0	56—0	38—0	26—0	9400	Gøtaverken	4000	6	29.13	43.30	100	13
Afrika	1920	East Asiatic Co.	Burmeister & Wain	464—9	60—0	42—0	31—5	13250	Burmeister & Wain	4500	6	29.13	43.30	110	12
Mexico	1920	"	Nakskov Yard	300—0	44—0	30—6	.....	4700	Danish Diesel Works	1600	6	19.70	29.50	140	10½
Asia	1919	"	Burmeister & Wain	442—6	55—0	38—6	29—1	10800	Burmeister & Wain	3100	6	24.80	37.80	...	11½
Stureholm	1919	Swedish: American Mexican Line	Gøtaverken	409—0	53—9	.....	26—0	7700	"	2800	6	23.28	35.48	130	11
Glenluce	1920	Glen Line	Harland & Wolff	420—0	54—0	23—5	.....	7800	Harland & Wolff	3100	6	24.80	37.80	130	11½
Glentara	1920	"	"	420—0	54—0	23—5	.....	6800	"	3100	6	24.80	37.80	130	11½
Glenade	1919	"	"	406—2	54—2	26—3	.....	5800	"	3100	6	24.80	37.80	120	11½
Buenos Aires	1920	North Star Line	Gøtaverken	425—0	56—0	30—6	25—5	9400	Gøtaverken	3100	6	24.80	37.80	...	11½
Balboa	1919	"	"	425—0	56—0	30—6	25—5	9400	"	3100	6	24.80	37.80	...	11½
Belgica	1914	Govt. of Belgian Congo	Societe John Cockerill	.....	.....	.....	.....	1500	Société John Cockerill	1900	6	16.93	16.93	280	....
Gleneriffe	1919	Glen Line	Harland & Wolff	406—0	54—2	.....	.....	10000	Harland & Wolff	3100	6	24.80	37.80	...	11
TOTAL.........53 Motorships								Total 412,170 tons d.w.c.		Total 150,280 i.h.p.					

*Sunk by mine or submarine.

NOTE.—All vessels are twin-screw, excepting the "Lidvard," "Landvard," and "Folkvard," which are converted steamers and have just been purchased by S. O. Stray & Co. from the Norwegian Govt. for $210.00 per d.w. ton.



The "Afrika"—one of the six largest motorships in the world. She is of 13,250 tons d.w.c. and is owned by the East Asiatic Co. (Danish), and is propelled by two 2,250 i.h.p. Burmeister & Wain Diesel-engines. Her trial speed was 13¼ knots. Loaded speed, 12 knots. The other largest motorships are the "Glenogle," "Glenapp," "Yorkshire" (British), "Wilhelm A. Riedermann" (German) and the "Maumee" (American)

World's Largest Motorships

Some Interesting Comparisons

In our March issue we published a description of the new 18,600 tons displacement motorship "Afrika" of the East Asiatic Line. We also gave an illustration showing this interesting Diesel-driven vessel just after she was launched. We are now able to reproduce a photograph showing this vessel as she appeared on her trial trip. She is said to be the largest motorship in the world, but in actual fact she is much about the same size as the British motorship "Glenapp," and a little smaller than the new Glen Line motorship "Glenogle," which also is of higher power and greater speed than the "Afrika." So really the British lead the Danes in this respect, particularly as the "Glenogle" is the first of four 13,500 tons 6,600 I.H.P. motorships for the Glen Line. She has been launched, but is not yet in service. The "Glenapp" also belongs to the Glen Line.

Furthermore, the new motorship "Yorkshire" of the Bibby Line, of Liverpool, is now nearing the launching stage at Harland & Wolff's Belfast yard, and she is even larger, being of 10,500 tons gross. Approximately this is 16,500 tons d.w.c. if purely a freighter, and of about 20,000 tons loaded displace ment.

We give below a table showing the general dimensions of the "Glenapp," "Glenogle" and the "Afrika," from which an interesting comparison can be made:

	"AFRIKA"	"GLENAPP"	"GLENOGLE"
Displacement (loaded)	18,600 tons	19,000 tons (about)	19,000 tons (about)
Length (o. a.)	464 ft. 6 in.	470 ft.	502 ft.
Length (b. p.)	445 ft.	450 ft. 5 in.	not available
Breadth	60 ft.	55 ft. 8 in.	62 ft.
Depth (moulded)	42 ft.	40 ft.	not available
Deadweight capacity	13,250 tons	9,600 tons and 1,700 troops	14,000 tons
Power	4,500 i. h. p.	6,600 i.h.p.	6,600 i.h.p.
Cubic-capacity (grain)	872,300 cu. ft.	not available	not available
Loaded speed	12 knots	13.5 knots	13–14 knots
Trial speed	13¼ knots	15 knots	not yet run
Grcss tonnage	9,050 tons	7,263 tons	9,200 tons
Net tonnage	5,468 tons	4, 623 tons	not available
Daily fuel consumption	13 tons	24 tons	24 tons

The trial trip of the "Afrika" was run on March 27th, and an average speed of 13¼ knots was obtained over the measured mile, as a mean of several runs. It is a point of interest to note that the trial trip was attended by the United States Naval Attaché of Copenhagen, Captain Kenneth I. Castleman; also by the United States Military Attaché, Col. D. W. Holloday and by two representatives in Denmark of the U. S. Shipping Board, namely Messrs. Ulrich and Robert Bell.

Each of the cylinders of the twin six-cylinders of the "Afrika" have a diameter of 29.4 in. winches and a piston-stroke of 47.24 in., and are designed to develop 2,250 I.H.P. each at 150 R.P.M. On the trials of the ship, with the vessel light, the speed of 13.2 knots was attained with the engines turning at 122.8 and together indicating 4,778 I.H.P. on a fuel-consumption of 138 grams per I.H.P. hour. The total daily consumption for all purposes is 16.3 tons.

The machinery staff consists of 15 men, namely, chief-engineer, second, third and fourth engineers, 6 assistant-engineers, 4 oilers and 1 electrician. This compares most favorably with the engine-room and boiler-room staffs of a steamer. For auxiliary purposes there are four non-reversible Diesel-engines driving electric-generators, three for power for the winches, electric-light, pumps, air-compressors, etc., and one for the No. 3 hold, which is insulated for perishable cargo. There is a small donkey-boiler for heating the fuel-bunkers in the double bottoms and the crew's accommodations.

MOTORSHIP AND DIESEL-ENGINE ORDERS ON HAND AT BURMEISTER & WAIN PLANT. A TOTAL OF 51 NEW VESSELS

On another page is given a list of 52 motorships now in operation, which were built by Burmeister & Wain and their licensees. We are able to state that Burmeister & Wain themselves have orders on hand for 34 complete motorships ranging from 6,500 tons d.w.c. (2,600 I.H.P.) and 13,600 tons d.w.c. (6,600 I.H.P.) for the following companies:

The East Asiatic Company, Copenhagen, Denmark.

Fred Olsen Line, Christiania, Norway.

Thoresen Line, Christiania, Norway.

Nordenfjeldske Line, Tonsberg, Denmark.

Johnson Line (North Star), Stockholm, Sweden.

Swedish East Asiatic Co., Ltd., Göteborg, Sweden.

Wilh. Wilhelmsen Line, Tonsberg, Denmark.

In addition to these 34 motorships, Burmeister & Wain are constructing the Diesel engines for 17 motorships now building at other yards in Denmark, Great Britain and Sweden.

The United Steamship Co., Copenhagen, Denmark.

Moller Line, Copenhagen, Denmark.

Ocean Steamship Co., Liverpool, England.

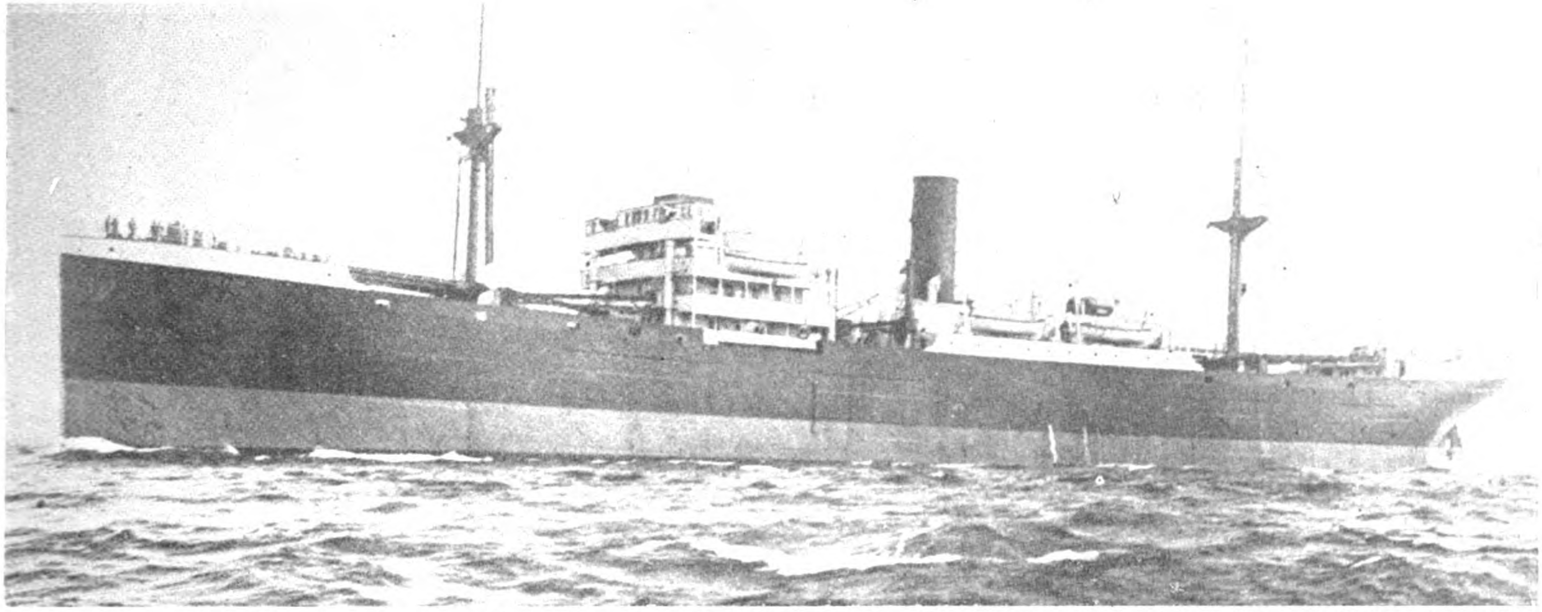
Atlanterhabet Steamship Co., Copenhagen, Denmark.

Gylfe Steamship Co., Copenhagen, Denmark.

East Asiatic Co., Ltd., Copenhagen, Denmark.

WHAT BRITISH SHIPBUILDERS ARE DOING!

On page 406 of our May, 1920, issue we gave a list of 24 leading British shipowners who are to-day building large merchant motorships.



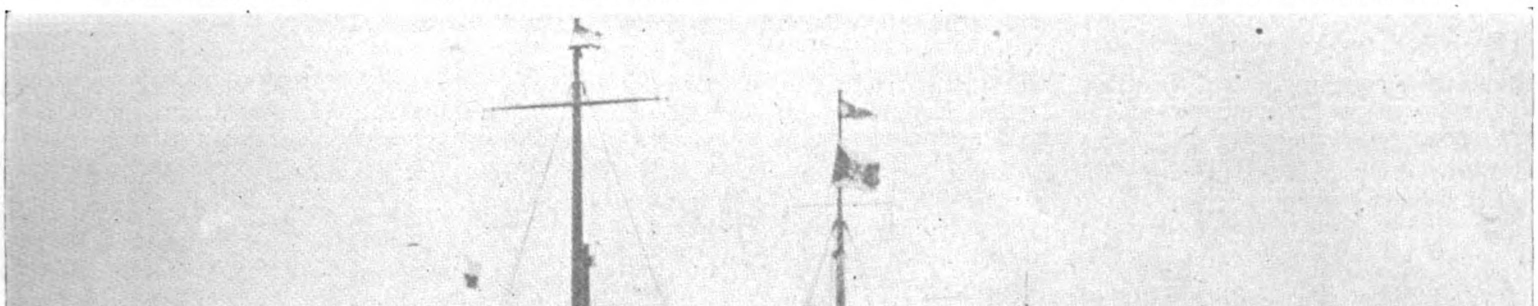
The new Harland & Wolff built motorship "Glentara" of the Glen Line which has just run her trials. This well-known British steamship line now owns nearly a dozen motorships, including the "Glenapp" and the "Glenogle," the two highest powered and largest motorships afloat

MOTORSHIPS COMPLETED IN BRITISH ISLES BY HARLAND & WOLFF

Year	Ship's Name	Gross Tonnage	Shaft H.P.
1914	†Ex "Bandon".........	3485 tons	1250
	†Ex "Pangan".........	3485 "	1250
	"Mississippi"	4717 "	2500
1915	"Kangaroo"	4348 tons	1700
1915	†Ex "Chumpon".......	3485 "	1250
	"Falstria"	4344 "	1700
	"Glengyle"	6225 "	2300
1916	"Glenartney"	7239 tons	2600
	"Glenamoy"	7239 "	2600
1917	"Glenavy"	5875 tons	2300
1918	"Glenapp"	7373 tons	4900
1919	"Glenade"	6502 tons	2400
	"Glenariffe"	6795 "	2400
1920	"Glenuce"	6800 tons	2400
	"Glentara"	7500 "	2400
	*"Dorsetshire"	9200 "	4900
	*"Glenogle"	9200 "	4900
	*"Yorkshire"	10400 "	5500

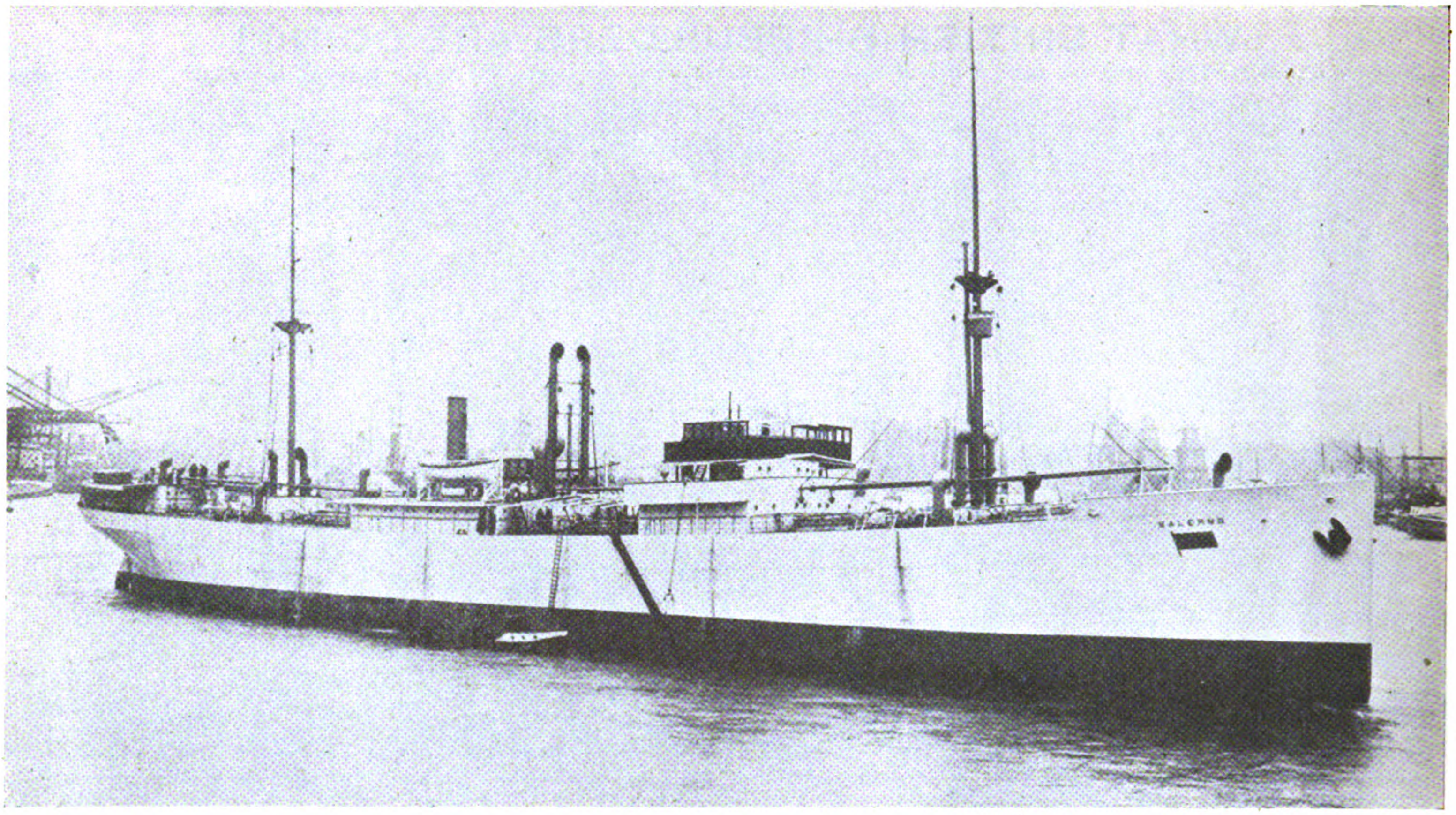
*Trials not yet run. †Converted from steam.

TOTAL=18 MOTORSHIPS.



The British motorship "Glengyle" fully loaded. Like the other motor-vessels of the Glen Line, she is propelled by Burmeister & Wain type Diesel-engines

WAKE UP—AMERICAN SHIPBUILDERS AND SHIPOWNERS!



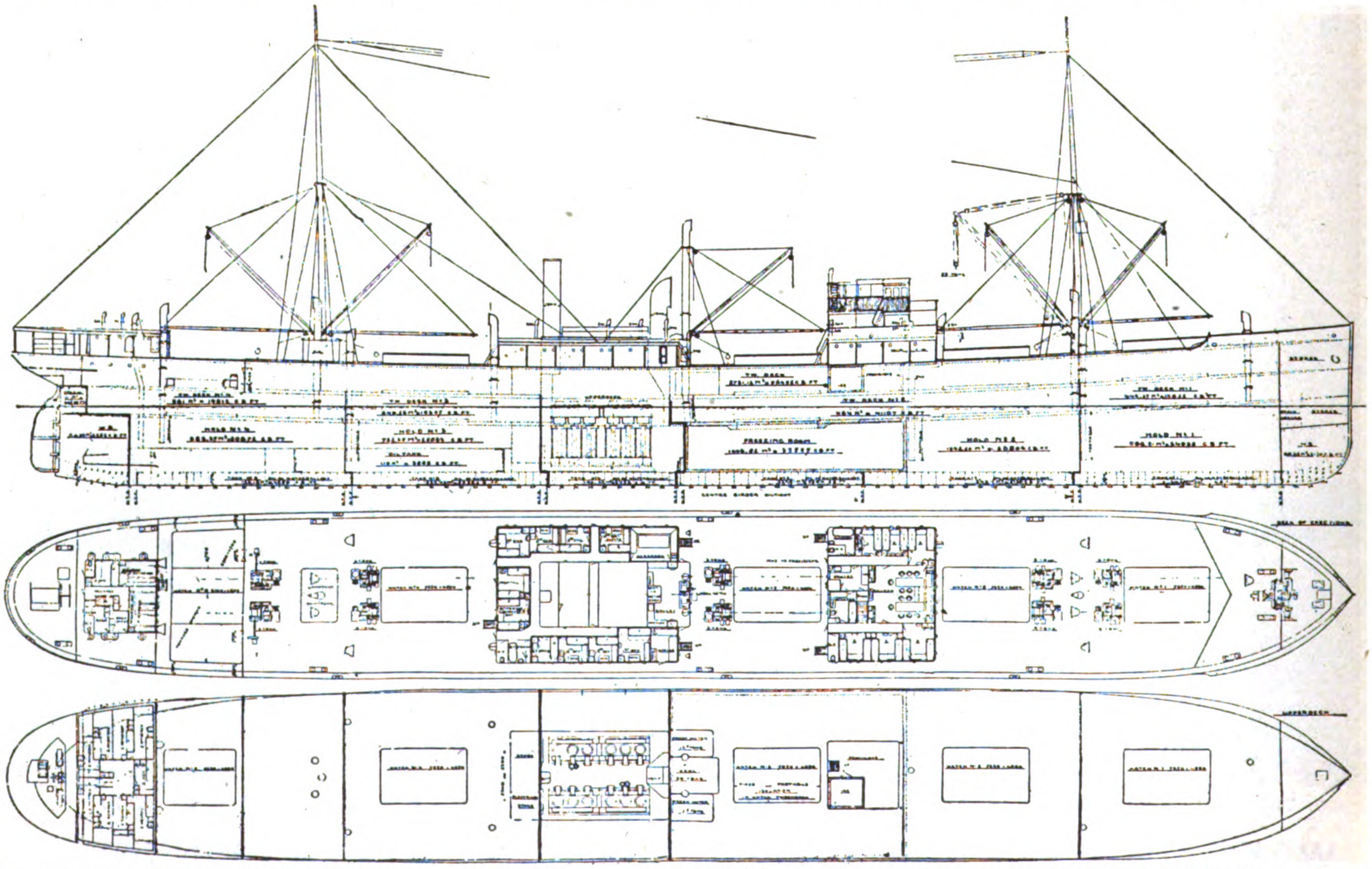
The new 6,500 tons d.w.c. motorship "Salerno" built in Holland for Norwegian owners

The New 6,500 Tons D.W.C. Motorship "Salerno"

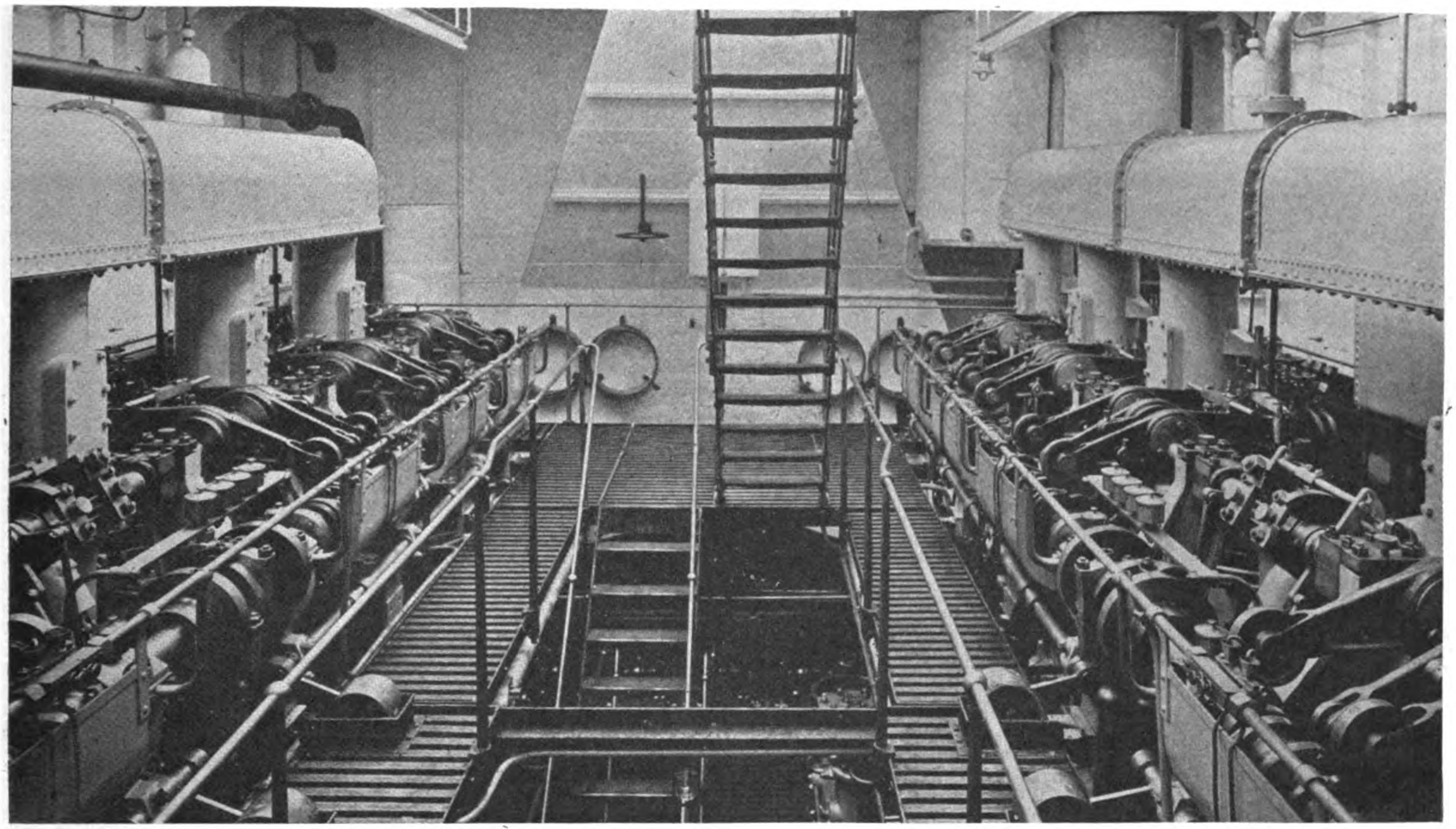
Dutch-Built Diesel-Driven Freighter for Norwegian Owners—Twenty-Eight Hundred Horsepower in a 40-Ft. Engine-Room

By "Starboard Watch"

PRIOR to the commencement of the great war there were two big companies whose productions of ocean-going Diesel-engined motorships were far ahead in numbers of those of any other concern. One of these was a Danish shipyard which had the financial and moral backing of a powerful overseas trading firm, while the other was an old Holland engineering plant which was given the support in its oil-engine development work, of one of the two great oil-companies of the world, who at that time foresaw that if oil was to be the fuel of the future for merchant ships, it must be used in the most economical manner possible and not wasted. With this object partially in view, and with the idea of economical operation of their own oil-transporting fleet they gave every encouragement



Profile and plan drawings of the Werkspoor Diesel-engined motorship "Salerno." Note the very small space occupied by the engine-room, and absence of deep-tank and bunkers. Fuel-oil is all carried in the double bottoms

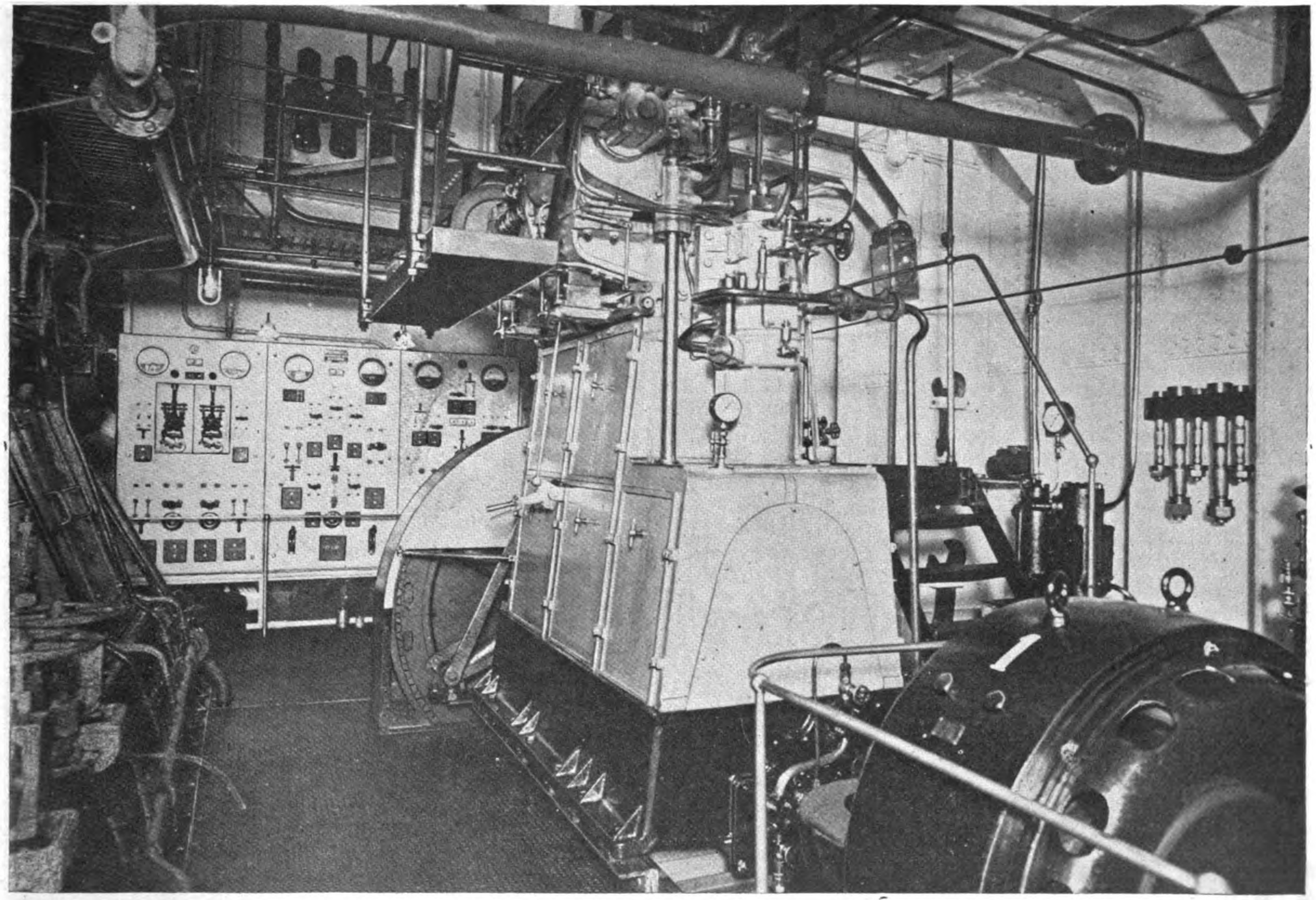


Engine-room of the new motorship "Salerno" of the Otto & Thor Thoresen Line of Christiania, Norway. It is painted white, as are the engines. Its length is but 40 ft. and the power is 2,800 i.h.p.

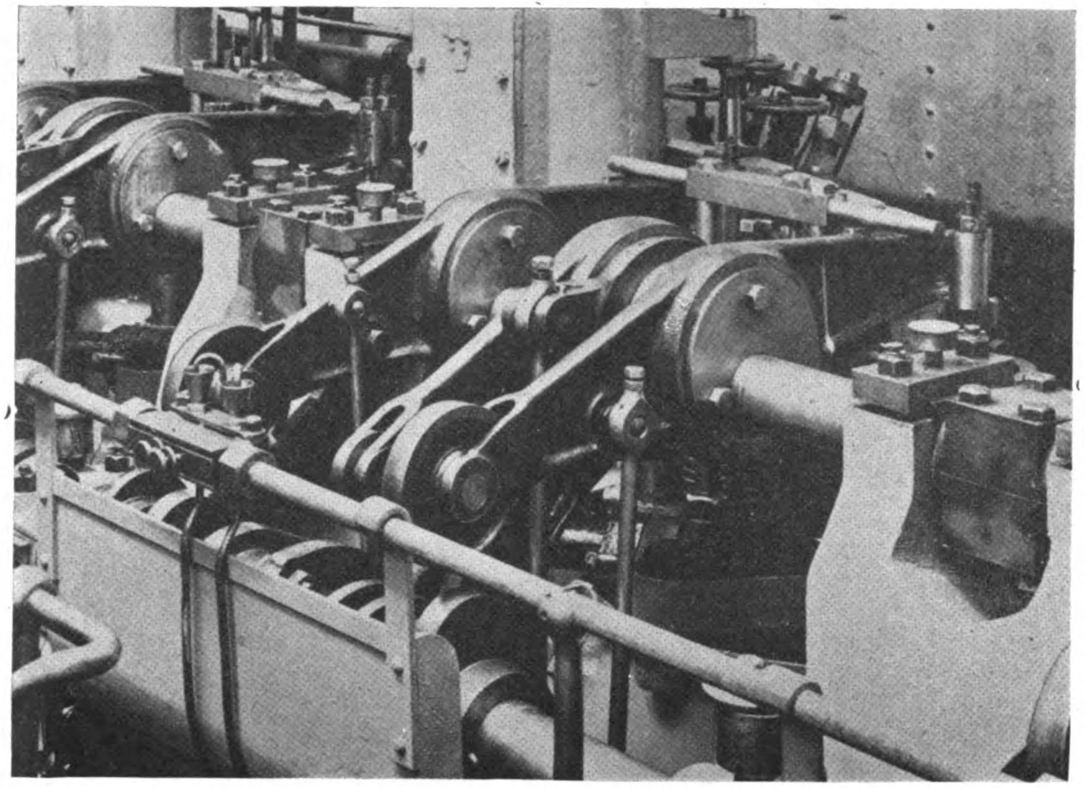
to these Dutch engineers to develop the Diesel-engined motorship, and it is no longer news how the little "Vulcanus" resulted at the end of 1910, and she was the first full-powered ocean-going Diesel-driven motorship afloat.

With this strong encouragement both the Dutch and the Danish firms had completed quite respectable sized fleets of motorships by 1914-1915, and at that time were neck-and-neck in the race, the Holland company leading in point of numbers of ships in service, but the Danish concern ahead in tonnage and horsepower.

Then came the shipbuilding material shortage. This was particularly felt in Holland, owing to both the German and allied supplies being practically entirely cut-off, and while Denmark had difficulty in securing material, her situation was not quite so bad, as her relations with the Allies was a little more favorable to importing steel. Nevertheless, she did



Engine-room of the motorship "Salerno," showing one of the new design of Werkspoor Diesel-electric generating-sets



Close-up view of the new diagonal-eccentric rocker reversing mechanism of the Werkspoor Diesel-engines of the motorship "Salerno"

have a serious shortage, and her output of motorships was badly hampered and consequently limited. On the other hand, the Dutch company was unable to secure sufficient steel to complete a single merchant-marine Diesel engine from the early part of 1915 right up until towards the end of 1919, although overwhelmed with orders. This resulted in being left behind in the race for the greatest fleet of motorships.

I refer to the Werkspoor Engineering Works, of Amsterdam, Holland, and during February last the trials of the motorship "Salerno" were successfully run, and the vessel left for South America. This ship was propelled by the first pair of Werkspoor Diesel-engines completed since 1915, and is the first of seventeen (17) Werkspoor-engined motorships now under construction in Holland and England for several Norwegian shipowning companies, aggregating about 85,000 tons d.w.c. and 40,000 I.H.P. A list of most of these vessels and their owners, tonnage, power, etc., already has been published in "Motorship," while plans of three were published on page 131 of the February, 1920, issue. She has twin screws.

[In our last issue we gave a full-page halftone plate of the new ship "Salerno."—*Editor, "Motorship."*]

This interesting new vessel was built at the J. & K. Smit Shipyard, Kinderdijk, Rotterdam, for the Otto & Thor Thoresen Line, of Christiania, Norway, and has the following dimensions:

Dead-weight capacity	6,500 tons
Length (o. a.)	390 ft. 10 in.
Length (b.p.)	375 ft.
Breadth (moulded)	51 ft.
Depth (moulded) to extended bridge	34 ft.
Depth (moulded) to Main Deck	25 ft. 6 in.
Draught	23 ft. 1 in.
Height of Shelter Deck	8 ft. 6 in.
Gross tonnage	3,907 tons
Block co-efficient	0.765
Power (maximum)	2,800 i.h.p.
Power (normal)	2,560 i.h.p.
Shaft horse-power	1,650 b.h.p.
Main engines	Twin six-cylinder Diesel
Bore and stroke	22.047 in. by 39.370 in.
Engine speed (max.)	125 r.p.m.
Total power of auxiliary Diesels	365½ b.h.p.
Propellers (4-bladed) 11 ft. 8 in. diam. by 10 ft. pitch, with 3.6 sq. metres working surface	
Ship's speed (loaded)	11 knots
Daily fuel consumption (incl. auxiliaries)	9 tons
Mean pressure (nor. load)	6.25 kg. per sq. centimeter
Mean pressure (max. load)	6.85 kg. per sq. centimeter

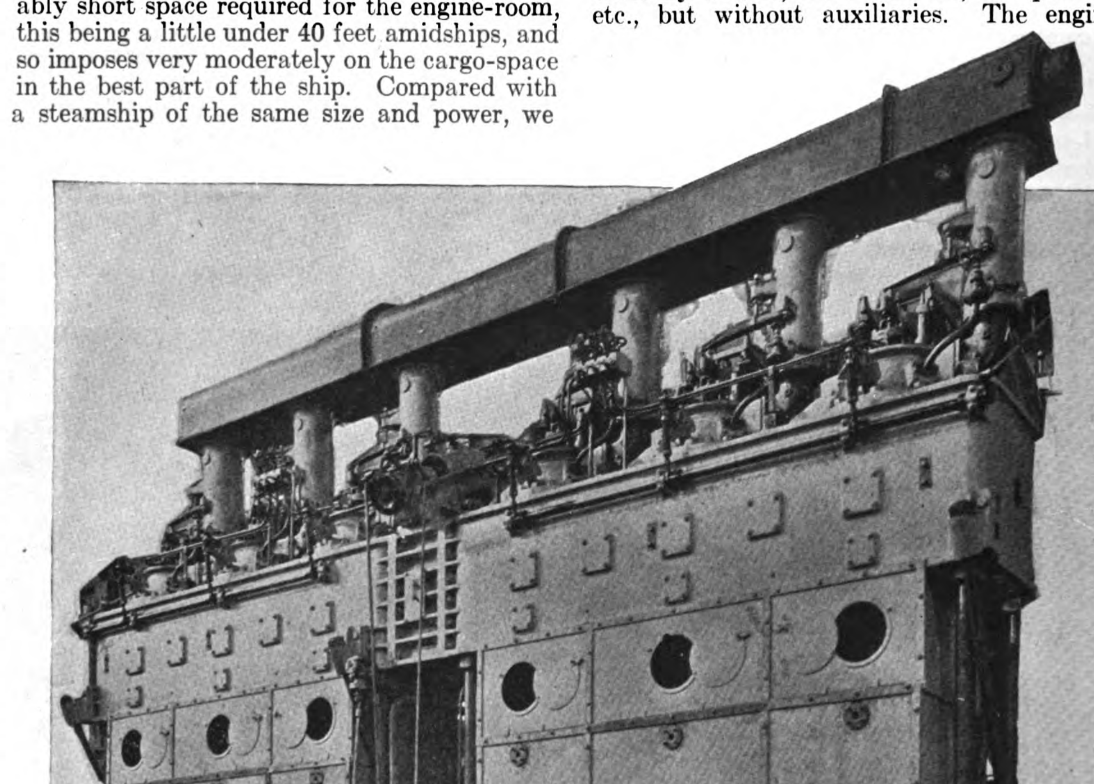
A study of the plans will reveal the remarkably short space required for the engine-room, this being a little under 40 feet amidships, and so imposes very moderately on the cargo-space in the best part of the ship. Compared with a steamship of the same size and power, we estimate that at least 20 ft. of machinery-space is saved. What this means in additional cubic cargo-capacity can easily be figured out by shipowners. Furthermore, there is no deep-tank, neither would the same ever be necessary even on a voyage round the world, so here again is about 15 ft. gain.

This means that compared with an oil-fired reciprocating steamship there is a space gain of close upon 35 ft. in the widest part of the hull.

This alone, apart from fuel-economy, must add enormously to the earning power of the vessel, and it is almost inconceivable that so many American shipowners should be so slow in ordering motorships.

Incidentally, it would seem that regardless of the claims of many two-cycle Diesel engine builders these four-cycle engines occupy less space, as they are within 30 ft. long—although six-cylinder sets—and together weigh but 240 tons with flywheel, air-compressors, cooling-pumps, thrust-block, etc.; but not including the engine-room auxiliaries, which I estimate will bring the total machinery weights up to approximately 300 tons.

Here, I may mention that the total machinery weights, without shafting and propellers, of a pair of larger four-cycle engines of the same make, but having a combined output of 4,280 i.h.p. (3,080 shaft h.p.) is about 425 tons; or 360 tons for the two main-engines with fly-wheels, thrust-blocks, compressors, etc., but without auxiliaries. The engine's



One of the 1,400 i.h.p. Werkspoor Diesel-engines of the motorship "Salerno." Technical details were given in our issue of November, 1919

length with Kingsbury thrust-block is about 40 ft.

A pair of these Werkspoor engines are being installed in the motorship "Storfond" (9,500 tons d.w.c.) now building at the same yard for the Dampskib Storfond A. S. of Stavanger, Norway, so the question of comparison is important.

This weight is vastly different from the figures quoted for four-cycle Diesel-engines of this power in the article by Sulzer Freres in the March and April issues of "Motorship." They quote 876 tons for the two main-engines, or 1,169½ tons for the total machinery weight without propellers and shafting.

For their own two-cycle Diesel-engined twin-screw set of this power, Sulzers quote 680 tons without propeller and shafting. Thus there is a gain in favor of the Werkspoor four-cycle engined machinery of 259 tons. For the main-engines alone the saving in weight in favor of the four-cycle engine is 60 tons, as the pair of Sulzer two-cycle engines weigh 420 tons.

True, the Sulzer 1,600 shaft h.p. engines run at 85 R.P.M. instead of 100 R.P.M. for the large four-cycle engines; but, practical experience with motorships in service has proved that over a year's average a propeller-speed of 100 to 125 R.P.M. shows most excellent efficiency; in fact, far better than the slow-turning propellers of steamships. These figures form an answer to the claims of Sulzer Freres!

The "Salerno" is propelled by twin six-cylinder, four-cycle single-acting, direct-reversible Werkspoor Diesel heavy-oil engines of 1,400 i.h.p. each. The engines were fully described and illustrated on pages 54 to 59 of "Motorship," November, 1919. They have a cylinder bore of 22.047 in. and a piston-stroke of 39.370 in., and the rated power is produced at a mean indicated-pressure of 89.2 lb. per sq. inch, giving a mechanical-efficiency of 72 per cent. Their guaranteed fuel-consumption is 0.33 lb. per i.h.p. hour, but in actual service is about 0.30 lb. or a little under—equivalent to 0.40 lb. per shaft h.p. Its overall length, without fly-wheel and thrust, is only 39 ft. 4¼ in., and its weight with fly-wheel, thrust, air-compressor, etc., is 120 tons. As you have previously described the design and construction of these engines, I do not propose to repeat the same at this juncture.

All the ballast tanks in the double-bottom of the ship are constructed to carry oil-fuel, but as 450 tons of oil-fuel will take her over 12,000 nautical miles at 11 knots, it will be understood that when carrying dead-weight, compact cargo, such as machinery, coal or ore, there is no need to fill all her bunkers, and thus she can take a maximum load in her holds.

On the other hand, if she is carrying a light, bulky cargo, such as cotton, her fuel-bunkers can be filled to the limit, and upon reaching her home port the unrequired surplus of fuel could be sold as cargo or supplied to a sister ship, because oil is around $50.00 per ton in Norway and also is very scarce.

All the auxiliary machinery is Diesel-electric driven, the only steam on board being a donkey-boiler for steam-heating the ship, and when in operation this uses more oil-fuel than all the auxiliary Diesel-engines combined. It has a heating-surface of 12 sq. ft. and a working-pressure of 100 lbs. It is oil-fired. For feeding this boiler there is a Duplex donkey-pump.

There is a Werkspoor four-cylinder Diesel-engine of 160 b.h.p. at 250 R.P.M. coupled to a 110 k.w. electric-generator at one end and by a valveless auxiliary air-compressor at the other.

There also are two Werkspoor twin-cylinder Diesel engines of 80 b.h.p. each direct-coupled to a 50 k.w. electric generator, and one of these can be seen in the engine-room illustration with the switchboard in the background.

For emergency electric-lighting there is a 7½ b.h.p. Atlas oil-engined generating set. There is one other Diesel, and that is a Werkspoor single-cylinder 38 b.h.p. engine operating the Linde refrigerating machines.

The following constitute the remaining engine-room auxiliaries:

One Electrically-driven (geared down) emergency air-compressor.
One Cooling-water pump of 150 tons per hour capacity operated by a 16 h.p. electric-motor.
One Ballast-water centrifugal-pump of 150 tons per hour capacity, operated by a 30 h.p. electric-motor.
One Spare lubricating-oil plunger-pump of 7½ tons capacity per hour, driven by 6 h.p electric-motor geared down.
One Spare double-acting plunger-pump for bilge and piston cooling-water of 15 tons per hour capacity, driven by 6 h.p. electric-motor geared down.
One Spare low-pressure fuel-oil rotary-pump of 4 tons per hour capacity. Driven by electric-motor
One Spare high-pressure fuel-oil pump of 4 tons per hour capacity driven by steam or compressed air.
One Spare Refrigerating machine driven by 4 h.p. electric-motor.
One Ammonia Condensor 45 sq. meters cooling-surface.
One Brine Cooler.
Two Centrifugal Brine-pumps of 20 cubic meters capacity per hour (one a spare)

For handling the cargo there are ten (10) Swedish-built electric winches on deck. Two of 5 tons, and eight of 3 tons lifting capacity. There also is an electric-hydraulic steering-gear, and electric windlass.

The owners of the "Salerno" have seven other Werkspoor Diesel-engined motorships under construction, as follows: the "San Miguel," "San Paulo," "Sardinia," "San Andreas," "Sevilla," "Segovia," and one as yet unnamed. The owners of the remaining ten Werkspoor-engined motorships are K.Salvesen of Kragero; Det Norske Handelskip A. S. of Christiania; Winge & Co. of Christiania; P. Kleppe Rederi of Bergen; Dampskib Expedit A. S. of Stavanger; and the Dampskib Storfond A. S. of Stavanger. Four of these vessels are building for Winge & Co.

WM. DENMAN'S LETTER TO SENATOR WESLEY L. JONES—EX-CHAIRMAN OF U. S. SHIPPING BOARD, ADVOCATES MOTORSHIPS FOR AMERICA'S MERCHANT MARINE

(*From Part 38 of the Hearings Before the U. S. Senate Committee on Commerce*)

Re the Neglected Proposal for Diesel Motorships for American Mercantile Marine

Senator Wesley L. Jones,
United States Senate,
Washington, D. C.

April 8, 1920.

My Dear Senator Jones:

Long prior to my appointment to the Chairmanship of the Board the Diesel motorships had established their supremacy over steam in economy and practicability for overseas carriage. Many fleets were in successful operation, and our own Navy Department had employed them in the carriage of coal.

The Burmeister & Wain motor for some years had been perfected to a point where engineers of average ability could operate them with running schedules and absence of breakdowns, comparable with the standard types of marine steam-engine.

Its economies in labor and fuel and its enormous cargo savings in both weight and space had been demonstrated on over a score of ships and in scores of voyages.

Very early in my Chairmanship I stated our determination to make the Diesel motor our administrative contribution to the American Mercantile Marine. I purposed to introduce it gradually during the war, and had my plans been carried out we would have had a substantial Diesel fleet to-day and the shipping public educated to its use.

With the passing of the war, I am free from the restraint I have laid upon myself to suggest a criticism on my successors in office. My tribute to their many accomplisments I rendered at the sessions of the Commerce Committee in 1918. Their failure to accept or commandeer the services and plant of the Cramps and their associates for the construction of this fleet of 24 Diesel vessels is a colossal blunder for which even the rush and absorption of other activities seems an insufficient excuse.

Very faithfully yours,
WILLIAM DENMAN.

"GLENOGLE," ANOTHER BIG MOTORSHIP FOR THE GLEN LINE, LAUNCHED

Second Vessel of 6,600 I.H.P. For This Company to Take the Water

Another large Diesel-driven motorship for the Glen Line was launched at Harland & Wolff's Govan shipyard on April 15, 1920, named the "Glenogle." She has the following dimensions:

Displacement	19,000 tons (about)
Dead-weight capacity	14,000 tons
Actual cargo capacity of holds	13,000 tons
Speed	13–14 knots
Power	6,600 i.h.p.
Length	502 ft.
Breadth	62 ft.
Gross tonnage	9,200 tons

Two sets of 3,300 i.h.p. four-cycle type Burmeister & Wain Diesel-engines built at Harland & Wolff's Lancefield Quay Works are installed. All the deck winches, the steering-gear and other auxiliary machinery are Diesel-electric driven. The new 9,030 tons d.w.c. motorship, "Glentara," also of the Glen Line, ran her trials on April 13, 1920.

NEW HARLAND & WOLFF DIESEL ENGINE PLANT

For the purpose of increasing their output of merchant-marine Diesel-engines, Harland & Wolff have purchased the new Scotstoun big gun shops of the Coventry Ordnance Works, Ltd. This makes their third Diesel-engine works in Glasgow, and a new factory is being erected in Belfast.

MOTOR LINER FOR BIBBY & CO. LAUNCH OF THE "DORSETSHIRE"

The launch recently took place at Harland & Wolff's Belfast shipyard of a 10,500 tons Diesel-driven passenger and cargo motorship. The builders are installing Burmeister & Wain type Diesel engines built at their Glasgow plant. She has been named the "Dorsetshire." We understand that the keel for a sister motorship has been laid, also to the order of the Bibby line.

FLEET OF 200-TONS MOTOR-VESSELS

The first of a fleet of 200-tons twin-screw motorships for John Summers & Sons, shipowners, Shotton, England, was launched on April 21st from the yard of J. Crichton & Co., Connahs Quay.

Utilizing the Good Wooden Hulls

Unique Offer of an American Oil-Engine Builder Who Has Sufficient Confidence in His Own Product to Furnish Propelling Machinery Without Cost to the Shipowner

[It is now a well-known fact that the only really successful large American wooden ships are those fitted with heavy-oil engines, particularly the full-powered craft, as the small quantity of fuel required to be carried and used enables economical operation, contrasting with the coal-burning wooden vessels which on a long ocean voyage have little room for freight owing to the very heavy consumption of coal. We give publicity to an unusual communication from Mr. A. E. Parker, a practical business man, associated with the Sumner Engine Co. of Seattle, Wash.—*Editor.*]

THERE may be some merit to the propaganda circulated through newspapers and among shipping people relative to the wood vessels built by the Emergency Fleet Corporation of the United States Shipping Board to the effect that they are poorly constructed, of green timber and will not stand the severe strain of Atlantic voyage in winter season, but I want to say to you that some of the best wood vessels sailing the seas to-day were constructed of that same green timber. I have in mind the 106 schooners built at Port Blakely, Washington, by the Hall Brothers Shipbuilding Company during the past forty years. I witnessed the launching of No. 106 twelve years ago. Seventy-five per cent of the vessels built by Mr. Hall are still in existence carrying cargo between various ports of the world. Lloyds Registry of Shipping will verify this statement.

I built a barge fifteen years ago of green timber. Logs were pulled out of the water, passed through the saw-mill, placed in position in the barge and bolted. She was wrecked in a storm in Strs. Juan de Fuca, running on the rocks with a cargo, and her bottom was torn out. Afterwards she was salvaged and a new bottom plank of "green timber" was put on her, and she is still at work, with the timber nearly as good as when she was built. Since then I have been offered twenty-five per cent more than she cost fifteen years ago. *So much for green timber.*

I know of a vessel owned by the Shipping Board built by a man who learned his trade years ago in Mr. Hall's plant—a modified Ferris-type hull. The iron in her construction cost more than $38,000.00, pre-war prices. The lumber before the war would have cost $60,000.00. In 1916 the labor on a similar ship cost $80,000.00. There was no object for the contractor to slight this work. He was paid on a cost-plus basis. He understood his business and had all the money he required for the purpose. So why should he build anything but a good ship? The inspector on this vessel for the American Bureau of shipping was a sea captain who had sailed vessels for thirty years, told me that no better, stronger wooden ship was ever built; that if I wanted to equip her with power (internal-combustion oil-engines) he would take her to sea in any weather. In a recent letter Capt. Ross tells me in detail about the fastenings on this ship, and states "they are at least one-quarter greater than Mr. Hall or any other builder ever put in wooden vessel planks."

Up to this point we have a ship built by a first-class shipbuilder with good material and workmanship. Here I may draw attention to the fact that most of the trouble with wooden ships so far has been in the power department consisting of boiler trouble and steering-gear on first ships put into service.

I am going to equip this vessel with two heavy-oil internal-combustion engines of the Sumner type. Engines that are mechanically correct, both in design and workmanship. They furnish 760 indicated horse-power each, or 1200 shaft horse-power together, and can be constructed for approximately $100.00 per shaft horse-power, say $120,000.00 for the two engines. Without going into details about the engines, I will say that I will furnish the engines for this vessel and take an interest in the vessel for the amount represented.

The U. S. Shipping Board would like to have a demonstration of a modified Ferris vessel with internal-combustion engines for power, and will sell a vessel upon very reasonable terms at 5 per cent interest on deferred payments and with interest rates for money where they are at this time. It is better to handle it on their plan than to pay for the vessel with cash.

It will require an expenditure of $155,320.00 to place a house on the hull, put in oil-tanks that will give an operating radius of ten thousand miles, which is sufficient to get to ports where oil can be obtained or to return to your contract ports for oil.

This vessel is listed at 3800 D.W.T. I am told by the American Bureau she will measure 4000 D.W.T. She can be ready for sea at an entire cost of not more than $100.00 per D.W.T. She will use at present market price of oil $100.00 worth every twenty-four hours. She will have a speed of 10 knots, and will make considerable money for her owners at present rates, as she can carry cargo, where the existing wooden steamships have to carry bunker-coal. If rates go down very low she is not an expensive boat to operate. Consequently, we will be able to operate where a steam installation would have to remain in port.

Regarding the expenditure of $155,320.00 mentioned, I arrived at that amount in the following manner:

I propose to expend—

For the engine-house	$30,000
House equipment	10,000
Anchor winches	3,500
Electric steering-gear	4,000
Cargo winches	7,200
Donkey-boiler	2,000
Anchors and chains	8,000
Ice plant	3,500
Engine-room equipment	15,000
Oil-tanks	18,000
Shafts and propellers	20,000
Installation of engines	12,000
Recaulking of vessel	8,000
Contractor's profit, 10 per cent	14,120
Total	$155,320

Some of the equipment described above might be purchased from the Emergency Fleet Corporation upon the deferred payment plan, we thereby not having to furnish cash for the purpose. Of course, under the conditions outlined my company, the H. W. Sumner Company, must have control of the motive power in the vessel. The whole object of the plan is to make a practical demonstration of the internal-combustion engines manufactured by my company, installed in a modified Ferris-type vessel.

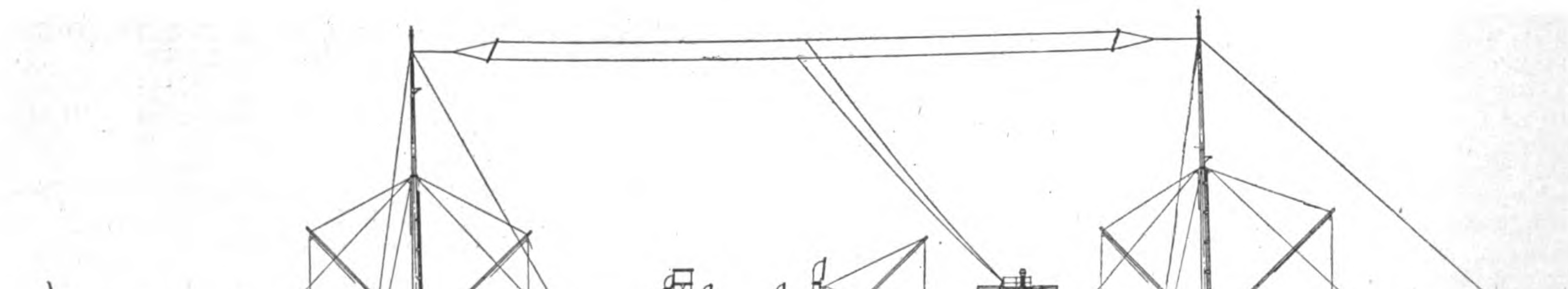
We have the vessel, the power and the freight to transport. Why not get the interested parties together?

If we can demonstrate that it can be done with one Shipping Board vessel, why cannot all the good hulls be put into service, and there are a lot of good ships owned by the Shipping Board?

ALBERT E. PARKER.

DIESEL AUXILIARIES OF THE LLOYD BRAZILEIRO

The two motor-driven auxiliary ships recently built for the Lloyd Brazileiro have been named "Brazil" and "Italia." Both vessels are of 2,300 tons d.w., and each is equipped with a 420 h.p. Sulzer two-cycle Diesel oil-engine as auxiliary propelling power.



Plans of one of the twin-screw 8,000 tons d.w.c. B. & W. Diesel-driven ore-carrying motorships building for the Grangesberg Company by the Götaverken. Length O.A. 399 ft.; length B.P. 385 ft.; moulded breadth, 53 ft. 5 in.; depth 26 ft. ¾ in.; draught 24 ft. 6 in.; power 2,600 i.h.p.

The Four-Cycle Versus Two-Cycle Marine Diesel Engine

A British Engineer's Reply to Messrs. Sulzer Frérès' Article

By JAMES RICHARDSON

THE article in your issue of March, pages 202 on the Sulzer marine two-cycle engine might very aptly be headed "The Two Versus the Four-Cycle Marine Diesel-Engine," and reopens many points of considerable interest. There is no subject in the internal-combustion world that has raised, and continues to stimulate such controversy as the relative merits of these two-cycles. Comparisons must always be drawn with the greatest care, lest incorrect deductions be the outcome, and where systems of marine propulsion are in question this is particularly necessary. So many and varied are the factors entering into the calculations. Furthermore, assuming the basis of comparison to be agreed upon, no two authorities would assess equally the relative values to be assigned to the leading deductions.

There should, however, always be a really serious effort to make the basis of comparison truly equitable. The installations described by Messrs. Sulzer are more readily compared than many others which have been chosen for this purpose in the technical press, since the speed of revolution of both the four-cycle and the two-cycle engines is identical at 85 r.p.m. On every other point, however, strong disagreement can be urged.

It is obviously necessary that the engines being considered should be capable of exactly the same duty. The normal full-power for *continuous* operation at sea should be the same figure. Let us examine these two engines from this point of view.

The four-cycle engines to give in six cylinders 1,600 B.H.P. must develop an average mean-effective-pressure on a B.H.P. basis of slightly less than 70 lbs. per square-inch, or allowing a ratio of I.H.P. to B.H.P. of 75 per cent, which should readily be attained allowing for the fact that all the auxiliaries except the fuel-injection air-compressor are separately driven. This means an actual average indicated mean-effective pressure within the cylinders *of less than 95 lbs.* per square inch *every second revolution.* Years of sea going experience have shown these figures to be good and sound practice.

With the two-cycle engines the figures are 77 lbs. per square-inch on a b.h.p. basis, and, allowing the same ratio of B.H.P. to I.H.P. since the scavenging-pumps are separately driven, the average indicated mean-effective pressure is over the 100 lbs. per square inch *every revolution.*

I do not know of any two-cycle engine at sea that operates continuously at more than 55 lbs. per square-inch on a B.H.P. basis. Such engines have always had the scavenging-pumps driven from the main engine. Allowing 10% of indicated power as being absorbed by these pumps, and the 55 lbs. per square inch becomes approximately 65 lbs. per square inch, and the m.e.p. in the cylinder less than 90 lbs. per square inch, which figures are still very much lower than those adopted by Messrs. Sulzer.

It may be that recent metallurgical developments and improved design of supercharging scavenging make such high figures as 77 and 100 lbs. per square inch possible, and sound practice for *continuous operation* yet it must be observed that with such a rating of engine as adopted by Messrs. Sulzer the amount of heat to be passed through the cylinder walls per unit of time and combustion chamber wall area *is more than double* the quantity for the four-cycle machine. No one cause has had a greater retarding effect on the successful application of internal-combustion engines than overrating the continuous power output capacity of a given size of engine.

The four-cycle engine with cylinders having diameters of 775 m.ms. and a stroke of 1,250 m.ms. must of course be much heavier than the two-cycle engine of four cylinders of 680 m.ms. and 1,110 m.ms. stroke approximately in proportion to the cylinder swept volume (seeing that the speed of revolution is constant).

The all important factor of engine rating will also serve to explain a part of the difference in weight and space occupied by these two engines.

When weight cutting is essential as in submarine practice, it can equally as well be accomplished with the four as with the two-cycle engine and the difference in weight between the lightest submarine engine four or two-cycle on a rating of *continuous* power output satisfactory sustained has been found in practice to be negligible. This is equally confirmed by British and German submarine experience.

Again, referring to figure 4, page 210, of "Motorship" it will be seen that the four-cycle engine has a built-up crankshaft. This makes for extra weight, but such a shaft has been found to be preferable for marine engines of such high powers and is favored by marine engineers. The two-cycle engine has a solid forged two-piece main crankshaft with no doubt the two parts interchangeable.

Figure 2, page 210, indicates the difference in turning moment between a four and a two-cycle engine each of the same number of cylinders. The two-cycle is much more regular, and even with four two-cycle cylinders there is an improvement in this respect over the six cylinder four-cycle engine. What does such difference amount to in practice? In the engine-room I defy the possibility of detecting any difference. In steadiness, silence, ease of running, efficiency, there is no loss or defect that it can be suggested an improved turning moment would remedy. For certain duties, the best turning moment possible may be necessary, and for others advantageous, but for marine work and comparing multi-cylinder engines, this question is more of a "talking point" than practical politics.

For reasons of keeping down the lubricating-oil consumption by preventing splash on to the cylinder walls, of obviating any unburnt or carbonized lubricating or even fuel-oil from finding its way into the crank-chamber and so contaminating the main lubricating-oil system, and to make as accessible as possible the gear for leading the piston-cooling medium to and from the main piston, it is a most desirable practice with cross-head engines to isolate the underside of the main piston from the crank-chamber.

This necessitates with the four-cycle engine a certain amount of extra height and so weight, but with the long piston required to keep the exhaust and scavenging ports with the two-cycle engine covered when the piston is at the top of its stroke, this extra weight has been regarded as prohibitive.

To reduce head room with the two-cycle engine, the piston is allowed to come down between the guides of which there are four, and an equal number of slippers per cylinder in order to make a compact arrangement. This arrangement should be compared with the standard marine simple single slipper arrangement adopted by four-cycle engine constructors.

The starting platform of the two-cycle engine-room is on the top grating as shown in Fig. 6. In an engine-room where there are many auxiliaries to supervise, it is the writer's opinion that the extra weight required to bring the controls down to the floor level is well expended, as this is the correct position from which to operate a marine plant.

These explanations may serve to explain much of the discrepancy in weight between the Sulzer two-cycle and a standard four-cycle engine. Continued experience with these relatively large cylindered four-cycle engines will probably show that the weight can be somewhat reduced without sacrifice of durability or reliability, and with high-powered two-cycle engines considerations of simplicity, accessibility and the necessity of conforming so far as possible to standard marine practice will be found to require some extra weight. So much for the main engines.

Consider the auxiliary engines. The four-cycle engines weigh, according to the tables given in Figures 5 and 6, 336 lbs. per B.H.P. and the two-cycle 194 lbs. per B.H.P. Practically the same reasons apply in their case as with the main engines.

To consider the other items in the table in which a weight difference in favor of the two-cycle is shown. Why should the shafting and propellers of the four-cycle installations be 25% heavier? Lloyds shafting co-efficients for a six-cylinder four-cycle and a four-cylinder two-cycle engine respectively are 0.409 and 0.40, and only explain a quite negligible extra weight for the four-cycle.

Similarly with auxiliaries, presupposing similar design of pumps, etc., these weights should be somewhat higher with the two-cycle arrangement, as the higher pressure starting air reservoirs are heavier, the scavenging-pumps have to be included, more cooling-water is required, and a slightly larger auxiliary compressor is necessitated to cope with the increased quantity of fuel consumed. If a saving of weight with the two-cycle is made by adopting higher speed pumps, such a course can, if desired, be equally well adopted with the four-cycle engine.

As regards space occupied the comparison again is faulty. If with the four-cycle arrangement, as is done in this case with the two-cycle, the fly-wheel be put in a recess, the passage way clearance between the aftermost cylinder and the bulk-head be cut down, the auxiliaries be spaced closer together and some of them placed athwartships considerable saving in space can be affected *if desired.* With the two-cycle arrangement no auxiliary compressor seems to be shown.

The fuel-consumption with the two-cycle engine is higher. On page 212 some 2.5% is admitted, but the general figure in the writer's experience is not less than 5% and generally nearer the 10% *for all purposes.* Lubricating-oil consumption is not mentioned, but is an extremely important consideration in view of the high cost of this oil. With separate and rotary scavenging-pumps, an improvement on the normal two-cycle figure will be achieved since with reciprocating pumps for this duty, the greater proportion of the oil used to lubricate the reciprocating parts of these pumps finds its way with the charge of air into the main cylinder and so is burnt and passes out with the exhaust.

Nevertheless, with the two-cycle ports in the cylinder liner and the main piston dipping down out the forced lubricated crank-chamber the lubricating-oil which finds its way into the cylinder or out through the exhaust ports and is finally burnt *is very much higher* than is consumed in the four-cycle engine.

I do not wish in any way to deny the future that lies before the two-cycle engine. It will not be made clearer by failing to recognize past performances or the leading principles upon which the successes have been achieved any more than past failures can be overlooked.

The four-cycle engine for marine work is the standard today. It will only really seriously be challenged for marine work when two-cycle engine designers squarely face the necessity for providing for moderate mean-effective pressures in the working cylinders, rigid structures, accessibility and ample auxiliaries.

Savings in weight and space in marine work are attractive, but must in no way be bought at the expense of absolute certainty and security of satisfactory operation *CONTINUOUSLY* at full power.

JAMES RICHARDSON.

[The illustrations referred to by Mr. Richardson were published in "Motorship" for March and April, 1920.—*Editor.*]

TYPICAL LARGE DIESEL ENGINES.

No. and Make.	B.H.P. per Eng.	No. of Cyls.	B.H.P. per Cyl.	B Bore. in.	S Stroke. in.	S./B. ratio.	R.P.M.	Piston Speed ft. per min.	M.E.P. lb. per B.H.P.
1. Burmeister & Wain	3,000	8	375	31·49	47·24	1·5	100	788	80
2. Werkspoor	1,560	6	260	26·378	47·24	1·79	110	868	72·5
3. Sulzer	4,000	6	666	32*	48*	1·5	100	800*	68·5*
4. Ansaldo	1,100	4	275	24·8	35·4	1·43	100	590	64
5. Doxford	2,200	4	550	22·947	45·67	1·99	77	585	74·5
6. Fullagar	1,000	4	250	18½	25	1·35	110	458	67
7. M.A.N. Engines of M. S. Fritz	900	3	300	18	28	1·55	120	560	75
8. Still	400	1	400	22	36	1·63	120	720	Oil, 63·2; Steam, 33·3 } Total 96·5

* Approximate figures.

A dimension table of large marine oil-engines recently published by the London "Times"

Interesting News and Notes from Everywhere

SHIPPING BOARD'S MOTORSHIP NAMED "WILLIAM PENN"

The U. S. Shipping Board's new 12,500-ton motorship, which was illustrated in our May issue, has been given the name of "William Penn." The launching will not take place until August next.

MOTOR-ENGINEER TRAINING SHIP

The 5,000 tons Diesel-engined auxiliary building at Leith by Ramson & Ferguson for the East Asiatic Company is nearing completion. This ship is for training engineers and officers for the East Asiatic Company's line of motorships.

PUSEY & JONES TO BUILD DIESEL-ENGINES

It has been known that for some time past Pusey & Jones, of Gloucester, Pa., have been experimenting with the Diesel-engine with a view to adopting for marine work. We understand that the construction of this type of engine will be taken up very shortly by this company.

NEW JAPANESE DIESEL FACTORY

A new factory for the construction of marine Diesel-engines will be completed next fall by the Niigata Tekkosho of Tokyo, Japan. It is expected that the out-put will be about 12,000 shaft h.p. per year. This firm already has a plant for the construction of surface-ignition type marine oil-engines, and their out-put for 1919 was about 120 engines of about 4,000 aggregated shaft h.p.

FINANCING MOTORSHIP CONSTRUCTION

If any of our readers contemplates adding to the present tonnage, the Marine Corporation, Alaska Building, Seattle, Wash., would be glad of an opportunity to discuss the question of negotiating for any necessary financing of ship construction, and the extension of shipping through the underwriting of bond issues or ship shares against steel merchant-ships in commission or under construction.

GOTAVERKEN CLOSE MORE SLOW-SPEED DIESEL ENGINE CONTRACTS

Contracts have been closed by the Götaverken, of Göteberg, Sweden, for three single-screw Diesel-engine installations of 1,600 I.H.P. each at 90 R.P.M. for three 4,000 tons ships building at different Swedish shipyards. They also have closed a contract for a 4,000 I.H.P. twin-screw Diesel engine set for a "Bullaren" type of cargo motorship now building at the Oresundsvarvet (Oresunds Shipyard), Landskrona, Sweden.

NORTHERN-PACIFIC COMPANY'S BIGGEST MOTORSHIP NAMED "THEODORE ROOSEVELT"

In esteem to the late Theo. Roosevelt the Northern-Pacific line has named their new 11,000-ton 14-knot motorship "Theo. Roosevelt." This vessel has just been completed by Burmeister & Wain of Copenhagen, and will be placed in operation on the route between the Northern Scandinavian ports and the Pacific Coast of the U. S. A. Of four other new motorships for this line two will be of 7,500 tons and two of 3,000 tons d.w.

LARGE SALVAGE MOTORSHIP
Vessel of 2,500 I. H. P. Under Construction

The most powered salvage-vessel ever built will be Diesel-driven. This unique motorship is now under construction at the Götaverken (Göta shipyard) Göteborg, Sweden, and will be propelled by twin 1,250 I. H. P. Burmeiser & Wain Diesel-type heavy-oil engines built under license. There also will be a very powerful Diesel-electric installation. She will be able to proceed to sea at a moment's notice, with the machinery cold, and will have a radius of 7,000 nautical-miles without refueling.

MOTORSHIPS FOR THE GRANGESBERG CO.

Frequent mistatements regarding the motorships on order for the Trafikatiebolaget Grangesberg-Oxelsund, of Stockholm, Sweden have appeared in the marine press. Reference to these vessels was made in our issue of November, 1919 and March, 1920 (page 219). Altogether there are 18 ships of 8,000 tons d.w.c. each, and the first pair will be steam propelled. The next four ships are being Diesel-engined by the Götaverken of Göteberg. The system of propulsion is decided as the hulls are laid down and it is probable that the remaining 12 ships will be Diesel powered, say the Götaverken. Burmeister & Wain of Copenhagen have no motorships on order for the Grangesberg Co.

ANGLO-SAXON PETROLEUM CO. BUYS TWO MORE DIESEL TANKERS
"Santa Margherita" Renamed "Marinula"

The 10,200 ton d.w.c. Vickers Diesel-driven motor-tanker "Santa Margherita" has been purchased by the Anglo-Saxon Petroleum Co. (Asiatic Petroleum Co.) from Sir Thomas Royden, who have renamed her "Marinula." The Anglo-Saxon Co. have also bought the Bolinder-engined motor-tanker "Oakol" from the British Admiralty and have renamed her "Orthis."

DIESEL FUEL FROM LIGNITE

By a retorting process it has been found possible to convert lignite obtained from the Dorsetshire deposits into solid fuel, during which process from 15 to 35 gallons of crude-oil are obtained. Upon distillation 3% of gasolene is secured, 10 to 30% of kerosene, and the residue is a valuable oil very suitable as Diesel-engine fuel.

VICKERS BUILDING EIGHT DIESEL-DRIVEN TANKERS

In our last issue we referred to Vickers having received an order for 16 solid-injection type Diesel-engines of 1250 shaft h. p. each. These motors will be installed in eight oil-carrying tankers for which they have received an order from Standard Oil interests. Other American Oil companies please note — and — get busy! American Diesel-engine builders await your pleasure.

PROPOSED DIESEL ENGINE ASSOCIATION OF MANUFACTURERS AND USERS

A vigorous attempt is being made to form a Diesel Engine Association among the manufacturers and users of this special type of power with a view to encouraging and furthering its development in every possible way. Owners and builders of Diesel-engined motorships should communicate with Mr. George A. Dow, President Dow Pump & Diesel Engine Co., Alameda, Calif.

OBTURATORS FOR DIESEL ENGINES

A paper on "Obturators" was recently read before the Diesel Engine Users Association of Great Britain by W. Fenvel. In pointing to the advantages claimed for the use of obturators in place of piston-rings in gasolene engines for aeroplane work the author referred to the actual power wasted in piston-ring friction in many cases as being as much as 75 per cent of the total mechanical loss in an engine. The obturator was described as a sort of "cup leather" made of thin metal. These were originally made of brass, but were now made of specially selected phosphor-bronze. They were usually placed very near the top of the piston, yet they did not burn, and this was explained by their flexible nature, which allowed them to keep in perfect contact with the cylinder and consequently well cooled.

The author had experimented with obturators in Diesel engines to a limited extent, and their life had been about 300 hours. Further tests were in progress, and he thought that a life of well over 1,000 hours could be expected with a new liner. With the successful use of obturators instead of piston rings the author considered that Diesel-engine design might be considerably modified, resulting in reduced height and weight, and that this would facilitate the introduction of cross-head engines, as the question of thrust surfaces did not then come in.

NEW SKANDIA ENGINED AUXILIARY SCHOONER

A Skandia heavy-oil engine has been installed in the 491 tons gross auxiliary schooner "Kathleen" built and owned by the Norris Arms Shipbuilding Co., Ltd., of St. Johns, Newfoundanl.

GULOWSEN-GREI ENGINED CONCRETE MOTORSHIP

Two 500 ton concrete motorships now under construction at Preston, England, will be powered with Gulowsen-Grei surface-ignition type heavy-oil engines.

MORE BRITISH CONCRETE MOTORSHIPS

Six British-built Kromhout surface-ignition type marine heavy-oil engines of 180 h. p. each are to be installed in three twin-screw concrete vessels now under construction in England. These vessels are of 1,000 d. w. c. and are 180 ft. long by 35 ft. beam, 19 ft. depth and 15 ft. draught. The first motorship is expected to be launched this month.

ITALIAN CONCRETE AUXILIARY SHIP

An auxiliary ship has been constructed of concrete in Italy by Signor Fedele Sacca. She is of 400 tons d.w.c. and is propelled by a 240 b.h.p. oil-engine and by sails.

LARGE CONCRETE DIESEL-DRIVEN MOTORSHIPS

Generally speaking the concensus of opinion among shipping men is that the concrete ship is a failure, as she costs more to build and takes longer to construct than a steel ship. Evidently everybody is not yet convinced of this because, as reported in a recent issue of this journal, the largest concrete motorship yet laid down—the "Triton"—was launched during March last at the Codan shipyard, Koge, Denmark. We are now enabled to give an illustration of this ship taken shortly after the launching. A sister concrete motorship is almost ready to take the water.

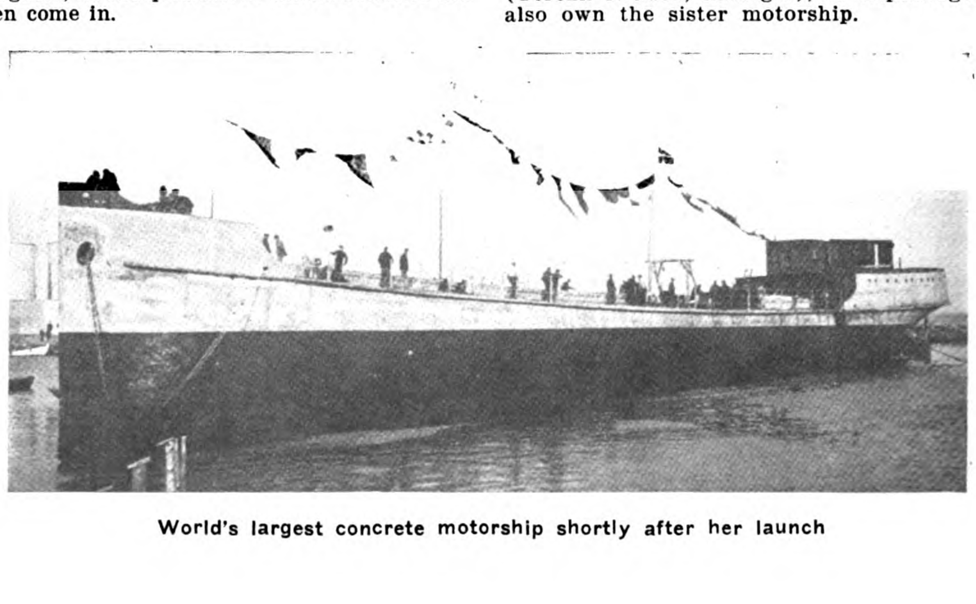
She is of special interest, as she is propelled by a new design of Diesel oil-engine built by a firm hitherto noteworthy in Denmark as constructors of steam machinery, but who some time ago also turned their attention to building the Brons type of marine oil-engine, which is better known in the U. S. A. as the Hvid. We refer to the Frichs Engineering Works of Aarhus, Denmark, who now are manufacturing Diesel-engines of the trunk-piston type up to 600 shaft H.P. and cross-head models from that power upward.

In the "Triton," a six-cylinder, four-cycle, single-acting Frichs Diesel-engine of 450 shaft H.P. is installed, turning at 120 R.P.M., which is a lower revolution speed than other trunk-piston Diesel engines of the power. The ship has the following dimensions:

Displacement	2300 tons
Loading capacity	1300 tons
Length	60 metres
Freadth	10 metres
Depth	5.5 metres
Draught (loaded)	4.85 meters
Power	450 shaft h.p.
Speed	8 knots

For driving the emergency air-compressor, electric-lighting, etc., there is a two-cylinder Frichs Diesel-engine of 35 H.P. She is a single-decked ship with officers and crew accommodations aft. Three hatches, each 8.7 metres by 5 metres, are provided for the cargo holds.

Her owners are the Triton Steamship Co. (Torehn Nielson, manager), of Copenhagen, who also own the sister motorship.



World's largest concrete motorship shortly after her launch

WHY MOTORSHIP ENGINEERS LEAVE!

We have just seen copy of a letter written to a well-known firm in San Francisco by a chief-engineer of a motorship, in which he states that the engines of his vessel ran without any trouble for ten months, and that the machinery is in excellent shape, but he is leaving the vessel because the food has not been satisfactory, and nothing could seem to change conditions. We have heard these complaints a number of times from engineers, and have made previous comments in these columns.

CAMMELLAIRD-FULLAGAR ENGINE PROSPECTS

Speaking at the annual meeting of the stock holders of the Cammel Laird & Co., Ltd., England, Mr. W. Lionel Hitchens, the chairman, said:—

"We acquired a few years ago the licensing and manufacturing rights of the Fullager internal-combustion engine in respect of oil-fuel, and have since then been carrying out experiments with a view mainly to the development of a marine engine. It was not, of course, possible to do much during the war, but since that date the experimental work has been pressed forward, and the results obtained justify the belief that the 'Cammellaird-Fullager' engine has a great future in front of it. After exhaustive trials in the shops, one of these engines is now installed in the 'Fullager' which was launched at Birkenhead the other day, and other units are in hand. Moreover, licenses to manufacturers have been applied for by some of the leading shipbuilding firms in the country. Experts agree that a great future lies in front of the marine internal-combustion engine, and there are strong grounds for the belief that the 'Cammellaird-Fullager' engines will prove a valuable asset to the firm."

MEXICAN PRODUCTS COMPANY

Mr. R. A. Brett has resigned as manager of the Chartering Department of the National Interocean Corporation to assume the management of the Mexican Products Company, a new concern holding a concession from the Federal Government of Mexico to exploit fishing, pearling, whaling, salt, animal and vegetable resources along the entire west coast of Mexico.

Mr. Pierce B. Watson will handle chartering in future for the National Interocean Corporation. The latter concern is completing a contract to handle the purchasing, selling and shipping interests of the Mexican Products Company, which will necessitate the establishment of branch offices in San Francisco, Los Angeles, Chicago, and New Orleans.

The National Interocean Corporation is in the market to purchase and charter tonnage for the Mexican Products Company and expects to commence operations on their behalf within the next ninety days.

COMPARE IT WITH YOUR STEAM-DRIVEN SHIP

The modern motorship will carry 100 tons of cargo a distance of one mile on a consumption of 1½ lbs. of fuel-oil.

SALVAGE CO.'S MOTOR VESSEL

A four-cylinder Fairbanks-Morse oil-engine has been installed in the wooden motorship "Doris and Reta," 195 tons gross, owned and built by the Southern Salvage Co. Ltd. of Liverpool, N. S.

THE BRITISH-BUILT SWEDISH-OWNED MOTORSHIP "ZAMORA"

"Zamora" is the name of the single-screw motorship which we reported in our last issue as having been ordered from the Palmers Shipbuilding & Iron Co., Ltd., Hebburn-on-Tyne, England, by the Rederiaktiebolaget Orient of Stockholm. Her dimensions are as follows:

Deadweight capacity	4900 tons
Length	330 ft.
Breadth	42 ft.
Draught	26 ft. 3 in.
Power	1600 shaft h.p.

Sulzer Diesel-engines of the two-cycle type are to be installed, and each will develop 800 shaft h.p. at 140 R.P.M. from four cylinders 18.50 in. bore by 29.13 in. stroke.

NEW MOTORSHIP LINE TO SOUTH AMERICA

A motorship service will be inaugurated between Vancouver, Seattle, San Francisco and Payton, Callo, Iquique, Valparaiso, etc., about June 15th next, when the McIntosh & Seymour Diesel-engined wooden motorship "Balcatta" clears from Vancouver. The Pacific Motorship Company are the operators of the new series, and four motorships will be placed on this line. General cargoes will be carried. Mr. W. Leslie W. Comyn of W. L. Comyn & Co., well-known in connection with the construction of the concrete ship "Faith" is at the back of this enterprise. Mr. R. J. Ringwood will be president. The other three motorships are the "Boobyalla," "Babinda" and "Benowa," sister craft to the "Balcatta."

DIESEL-ENGINED ITALIAN AUXILIARY BUILT IN GREECE

A 420 shaft h. p. Sulzer Diesel-engine has been installed in the 364 tons gross barkentine "Ernestina S" built by G. Rajola of Torre del Greco, Greece, and owned by the Societa Anom. Oelifici Nazionale, of Genoa, Italy.

BRITISH-BUILT BOLINDER ENGINED SHIP

The Bolinder-type heavy oil-engine built by Ruston, Proctor & Co. Ltd. has been installed in the old three-masted schooner "Elizabeth" built in 1892. She is of 155 tons gross and is owned by Mr. D. Williams of Carnavon, Wales.

EAST ASIATIC COMPANY'S REPORT

In our last issue we referred to the East Asiatic Co. (who own and operate motorships almost exclusively), having made a profit of Kr. 53,586,924.00 during 1919. In the company's report it is stated that as the motorships came to Denmark—in some cases after having been away for several years—the Diesel-engines underwent a thorough overhauling, from which it was seen that they had come up to expectation and only needed minor repairs.

On December 31, 1919, the fleet consisted of the following vessels:

		Built	Carrying capacity	I.H.P.
M S.	"Selandia"	1912	7,450	2,500
"	"Jutlandia"	1912	7,600	2,500
"	"Siam"	1913	9,940	3,300
"	"Annam"	1913	9,940	3,300
"	"Fionia"	1914	6,820	4,100
"	"Tongking"	1914	9,812	3,300
"	"Falstria"	1915	7,000	2,500
"	"Panama"	1915	9,812	3,300
"	"Australien"	1915	9,812	3,300
"	"Chile"	1915	10,400	3,300
"	"Peru"	1916	10,400	3,300
"	"Martinique"	1916	843	320
"	"Asia"	1919	10,400	3,300
"	"Dana"	1919	550	200
S S.	"Banka"	1919	2,350	710
	Total tons		113,129	

Since the above was issued their new 13,250 tons d.w.c. motorship "Afrika" has been placed in service. During the course of 1920 it is expected that the fleet will be increased by another 50,000 tons of motorships, including six motorships building at Nakskow yard. One of these is of 12,000 tons, one of 4,500 tons, two of 3,500 tons and two of 1,000 tons carrying capacity.

SMALL GERMAN MOTORSHIP

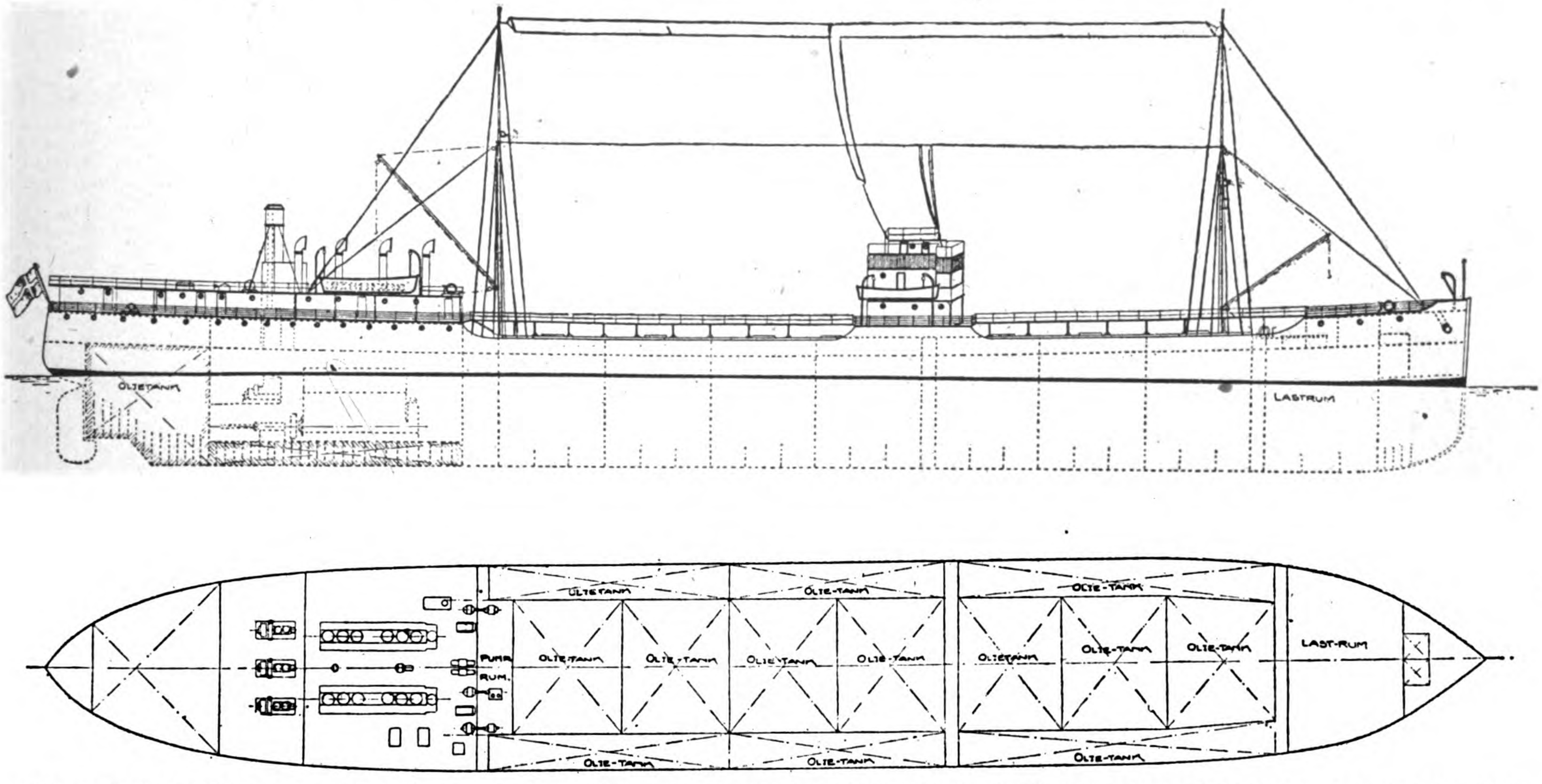
Ernst Harms, a Wilhelmsburg shipbuilder, has completed a 220-ton motorship for Wilhelm Boelstler & Co., shipowners, Hamburg. Trials have been run and a speed of 9 knots was attained.

NOVA SCOTIAN MOTORSHIP

Mr. A. Cook of Lunenburg, N. S. has taken delivery of the 950 tons gross wooden motorship "George M. Cook." This vessel was built by Smith & Rhuland of Lunenburg, N. S. and is powered with a Fairbanks-Morse oil-engine.

NAVIGATION TAUGHT BY MAIL

A course on navigation is now being taught by mail by the World Technical Institute, Fuller Building, Jersey City, N. J. The chief instructor is Capt. Warren Shepard formerly instructor for the U. S. Shipping Board, while the Chairman of the Advisory Board is Capt. Thomas Fleming Day, both who are well-known as experienced navigators and whose writings on marine subjects have made them famous all over the world.



Plans of the 7,500 tons d.w.c. Diesel-driven tanker building for the Rederi. Transatlantic of Göteborg at the Götaverken. Length O.A. 393 ft. 3 in.; length B.P. 380 ft. 3 in.; breadth 55 ft.; depth 30 ft.; draught 24 ft. 1 in. Twin 1,300 i.h.p. Swedish-built Burmeister & Wain engines are being installed. By reason of her operating-economy she will be able to deliver oil to their motorship fleet at lower cost than the same can be transported by the steam-driven tankers of American oil-companies